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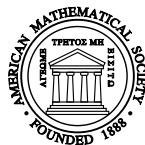
Spring 2012

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* Indicates who will present the paper at the meeting.

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PAPERS PRESENTED AT MEETINGS

THIS CALENDAR lists meetings of the Society which have been approved by the Council at which papers may be presented. Programs of Annual Meetings appear in the *Notices* and on the AMS website; programs for sectional meetings appear on the AMS Web pages in the Meetings & Conferences section, and are electronically archived in the *Notices* section on the AMS website.

MEETING #	DATE	PLACE	ABSTRACT DEADLINE	ABSTRACT ISSUE
1082	September 22–23, 2012	Rochester, NY	July 10	Vol 33, No. 3
1083	October 13–14, 2012	New Orleans, LA	August 28	Vol 33, No. 3
1084	October 20–21, 2012	Akron, OH	September 4	Vol 33, No. 4
1085	October 27–28, 2012	Tucson, AZ	September 11	Vol 33, No. 4
1086	January 9–12, 2013	San Diego, CA	TBA	Vol 34, No. 1
1087	March 1–3, 2013	Oxford, MS	TBA	TBA
1088	April 6–7, 2013	Chestnut Hill, MA	TBA	TBA
1089	April 13–14, 2013	Boulder, CO	February 19	TBA
1090	April 27–28, 2013	Ames, IA	TBA	TBA
1091	June 27–30, 2013	Alba Iulia, Romania	TBA	NA
1092	October 5–6, 2013	Louisville, KY	TBA	TBA
1093	October 12–13, 2013	Philadelphia, PA	TBA	TBA
1094	October 18–20, 2013	St. Louis, MO	TBA	TBA
1095	November 2–3, 2013	Riverside, CA	September 10	TBA

HONOLULU, HI, March 3–4, 2012

Abstracts of the 1078th Meeting.

03 ► *Mathematical logic and foundations*

1078-03-34 **John Goodrick**, Department of Mathematics, Universidad de los Andes, Bogota, Colombia, **Byunghan Kim***, Department of Mathematics, Yonsei University, Seoul, South Korea, and **Alexei Kolesnikov**, Department of Mathematics, Towson University, Towson, MD. *Amalgamation functors and homology groups in model theory, part I.*

In this joint work of John Goodrick, Byunghan Kim, and Alexei Kolesnikov, we develop basics of homology theory in a model-theoretic context and connect it with generalized amalgamation properties. This talk will introduce definitions of homology groups H_n , $n \geq 0$, associated to a family of “amalgamation functors”. Main results are: If the generalized amalgamation properties hold, then the homology groups are trivial; H_2 for strong types in stable theories are profinite abelian. (Received November 03, 2011)

1078-03-35 **John Goodrick**, **Byunghan Kim** and **Alexei Kolesnikov*** (akolesnikov@towson.edu), Department of Mathematics, Towson University, 8000 York Rd., Towson, MD 21252. *Amalgamation functors and homology groups in model theory, part II.*

This talk will continue the exposition of the work by John Goodrick, Byunghan Kim, and Alexei Kolesnikov. We will present examples illustrating the main notions, outline the proof of the “Prism Lemma” (an important technical result used in the calculation of the homology groups). Finally, we will compute the group H_2 for strong types in stable theories and show that any profinite abelian group can occur as the group H_2 in the model-theoretic context. (Received November 03, 2011)

1078-03-97 **Renling Jin*** (jinr@cofc.edu), Department of Mathematics, College of Charleston, 66 George Street, Charleston, SC 29424. *Nonstandard methods on density problems.*

Densities on an infinite set of non-negative integers are measurements of the asymptotic “size” of the set. Solving a problem on densities often requires a sequence of asymptotic arguments. Therefore, the density problems are good research subjects where nonstandard methods can be found to be powerful tools. In this talk the presenter

will survey some of his achievements on the applications of nonstandard methods to the density problems. (Received November 25, 2011)

1078-03-127 **Pavel Semukhin*** (pavel@semukhin.name), Department of Computer Science, University of Regina, Regina, SK S4S 0A2, Canada, and **Frank Stephan**. *Automatic models of first-order theories.*

I will talk about our joint work with F. Stephan in which we studied several model-theoretic properties of automatic structures. The topic of this research is inspired by computable model theory. In particular, we are interested in which results about computable structures can be transferred to the field of automatic structures. Typical questions here are: (1) Given $n \geq 1$, is there a theory with exactly n automatic models? (2) Which models of an uncountably categorical theory can be automatic? (3) If the saturated model of a theory is automatic, is the prime model also automatic? and so on. I'll discuss our progress on the above mentioned questions and talk about related open problems. (Received December 01, 2011)

1078-03-133 **John T. Baldwin***, Department of MSCS M/C 249 UIC, UIC 851 S. Morgan, Chicago, IL 60607. *Forcing to get model theoretic results in ZFC.*

The absoluteness of basic properties of first order logic was a cornerstone of late 20th century model theory. Recent analysis of similar problems for infinitary logic places the focus on the issue of whether \aleph_1 -categoricity forces amalgamation and ω -stability in \aleph_0 . We will consider several uses of set theoretic forcing to establish results in model theory that are provable in ZFC. This includes work with Larson extending Keisler's proofs that for certain infinitary logics the existence of uncountably many types over the empty set implies the existence of the maximal number of models in \aleph_1 and work with Shelah showing that a strong failure of exchange for a natural notion of algebraicity implies the existence of the maximal number of models in \aleph_1 . (Received December 01, 2011)

1078-03-142 **Hyeung-joon Kim*** (joon9754@yonsei.ac.kr). *Several notions of indiscernibility for trees and their applications to classification theory.*

Suppose we are given a set of elements indexed by a tree (i.e. a partially ordered set in which any two incomparable elements do not have a common upper bound). How can we define the notion of 'order type' for tuples in such a set? And we want to define it in such a way that allows us to prove the existence of an *indiscernible tree* (i.e. a tree in which any two tuples having the same order type realize the same type). The answer to this question is not so straightforward because there are several different ways to define the notion of order type in trees, and analyzing the existence of indiscernible trees requires rather complicated tools of infinitary combinatorics. S. Shelah originally developed this idea in his book Classification Theory, but we think some of his arguments are incomplete. In this talk, we clarify Shelah's definitions of order type for trees, and present clarified/revised arguments for the existence of indiscernible trees. We also discuss applications of indiscernible trees to problems in classification theory. (Received December 03, 2011)

1078-03-166 **Vincent N Guingona*** (guingona.1@nd.edu), University of Notre Dame, 255 Hurley, Notre Dame, IN 46556. *On VC-minimal theories.*

We discuss recent developments in our understanding of VC-minimal theories. First, we give some examples of theories that are dp-minimal but not VC-minimal using the idea of convex orderability. Next, we talk about canonical decompositions for formulas in a VC-minimal theory. Finally, we use this to compute the VC-density of formulas in a VC-minimal theory. Some of this work is joint with Joseph Flenner. (Received December 05, 2011)

1078-03-237 **Gregory Igusa*** (igusa@math.berkeley.edu), CA. *Nonexistence of Minimal Pairs for Generic Computation.*

In a recent paper, Jockusch and Schupp introduce and analyze the notion of generic computation. A generic computation of a real is a partial recursive function which correctly computes most of the bits of the real, but which may diverge on some inputs, provided that these inputs have an asymptotic density of 0 in the natural numbers. It turns out that this notion of computation has many properties that are rather counterintuitive from a recursion theoretic point of view.

We present our result that there are no minimal pairs for generic computation, in the sense that for any nonrecursive reals A and B , there is a real C , which is not generically computable, but such that C can be computed from either A or B . Downey, Jockusch, and Schupp proved this result in the case where A and B are both Δ_2^0 , and indeed this distinction appears to be significant, in that our technique requires a nonuniformity in the algorithm, based on whether one, both, or neither of the reals is Δ_2^0 . (Received December 10, 2011)

1078-03-257 **Nader Vakil*** (N-Vakil@wiu.edu). *On an externally defined class of uniform spaces.* Preliminary report.

Let (X, Λ) be a uniform space with its uniformity generated by a set of pseudo-metrics Λ , and let $({}^*X, {}^*\Lambda)$ be a nonstandard extension of (X, Λ) . Given $x, y \in {}^*X$, we write $x \simeq_\lambda y$ if and only if ${}^*\rho(x, y) \simeq 0$ for all $\rho \in \Lambda$, and we write $x \approx_w y$ if and only if ${}^*\rho(x, p) \simeq {}^*\rho(y, p)$ for each $\rho \in \Lambda$ and each $p \in X$. We call (X, Λ) an S -space if the relations \simeq_λ and \approx_w coincide on $\text{fin}({}^*X)$. We give a standard characterization of S -spaces, and discuss their basic properties. This discussion will include their hereditary properties and their projective and inductive limits. Applications to locally convex spaces will also be discussed.

(Received December 11, 2011)

1078-03-308 **Matt Insall*** (insall@mst.edu), 400 W. 12th street, room 315, Rolla Building, c/o Department of Mathematics and Statistics, Rolla, MO 65402-0020. *Ends of Representation Spaces.* Preliminary report.

Given a class \mathcal{C} of topological spaces, with no two members homeomorphic, let \mathcal{M} be a class of continuous surjections that is closed under composition. Topologize \mathcal{C} , in terms of a closure operator: Given a subclass \mathcal{P} of \mathcal{C} , write $(X, \tau) \in \text{Cl}_{\mathcal{M}}(\mathcal{P})$ iff for each open cover \mathfrak{C} of X , there is $(Y, \sigma) \in \mathcal{P}$ such that (Y, σ) is a \mathfrak{C} -image of (X, τ) via some element of \mathcal{M} . The resulting topological space is a **representation space**. The representation spaces of continua, constructed using ε -images, are especially interesting.

Ends of spaces fill “holes” in the space: they are formally defined using equivalence classes of nested nets of open sets with compact boundary whose closures have empty intersection. Attaching ends results in compactifications. Another approach is to define ends, using nonstandard methods, as equivalence classes of remote points: remote points x and y are identified iff there is an internally connected set A containing no nearstandard points, with $x, y \in A$. We detail the setting, motivation, and early results in the study of ends of representation spaces. (Received December 12, 2011)

1078-03-313 **Logan Axon*** (axon@gonzaga.edu), 502 E Boone Ave, MSC Box 2615, Spokane, WA 99258. *Martin-Löf random closed sets.*

In this talk we show how the definitions of Martin-Löf randomness can be extended to spaces of closed sets using the probability theory of random closed sets. The result is a very flexible framework for studying the algorithmically random closed subsets of sufficiently well-behaved topological spaces. We will focus on the closed subsets of 2^ω and \mathbb{R}^n . (Received December 12, 2011)

1078-03-323 **C Ward Henson*** (henson@math.uiuc.edu), Mathematics Department, University of Illinois, 1409 W Green Street, Urbana, IL 61801. *Uncountably categorical Banach space structures.* Preliminary report.

Model theory is applied to (unit balls of) Banach spaces (and structures based on them) using the $[0, 1]$ -valued continuous version of first order logic. A theory T of such structures is said to be κ -categorical if T has a unique model of density κ . Work of Ben Yaacov and Shelah-Usvyatsov shows that Morley’s Theorem holds in this context: if T has a countable signature and is κ -categorical for some uncountable κ , then T is κ -categorical for all uncountable κ .

Known examples of uncountably categorical such structures are closely related to Hilbert space. After the speaker called attention to this phenomenon, Shelah and Usvyatsov investigated it and proved a remarkable result: if M is a nonseparable Banach space structure (with countable signature) whose theory is uncountably categorical, then M is prime over a Morley sequence that is an orthonormal Hilbert basis of length equal to the density of M .

Questions: (1) can a stronger such result be proved, in which the connection to Hilbert space structure is clearly expressed in the geometric language of functional analysis? (2) what examples of uncountably categorical Banach spaces are known (or conjectured) and what light can they shed on question (1)? (Received December 12, 2011)

1078-03-329 **Akito Tsuboi*** (tsuboi@math.tsukuba.ac.jp), Tsukuba, Ibaraki 305-8571, Japan. *On Indiscernible Trees.*

An ordered set O is called a tree if, for any $a \in O$, its initial segment $\{b \in O : b < a\}$ is linearly ordered. The set $\omega^{<\omega}$ is a typical example of tree.

Let $M \models T$, where T is a (complete) theory in L . We are interested in sets $A \subset M$ of the form $(a_\eta)_{\eta \in O}$, where O is a tree, and a_η is an element in M . Such a set A is also called a tree.

Very roughly, a tree $A = (a_\eta)_{\eta \in O} \subset M$ is called an indiscernible tree if it has the following property: For any $X, Y \subset O$, if X and Y have a similar shape ($X \sim Y$), then

$$\text{tp}_L(a_X) = \text{tp}_L(a_Y),$$

where a_X is the set $\{a_\eta : \eta \in X\}$. This definition depends on the choice of similarity \sim , and there are several different notions of tree indiscernibility. The following is our main concern:

- (*) Let O be a tree and $\Gamma((x_\eta)_{\eta \in O})$ a set of L -formulas with free variables from the x_η 's. Is Γ realized by an indiscernible tree?

We will see that (*) has an affirmative answer (for many different notions of tree indiscernibility), if we impose homogeneity conditions on Γ . (Received December 12, 2011)

1078-03-354 **Jennifer Chubb Reimann*** (jcc31@psu.edu), University of San Francisco, Department of Mathematics, 2130 Fulton St., San Francisco, CA 94117. *Effective properties of approximable functions.*

We investigate the algorithmic properties of functions in the context of strong reducibilities (refinements of Turing reducibility). In particular, we consider effectively approximable functions (limits of uniformly computable sequences of functions), especially those that are limits of pointwise decreasing approximations. We will consider natural examples of such functions (in computable structures and otherwise) and make further investigations in the appropriate context. (Received December 13, 2011)

1078-03-363 **Denis R. Hirschfeldt*** (drh@math.uchicago.edu), Department of Mathematics, The University of Chicago, 5734 S. University Ave., Chicago, IL 60637. *The reverse mathematics of homogeneous models.*

I will discuss results on the reverse mathematical and computability theoretic analysis of basic model theoretic principles involving homogeneous models, in particular recent work with Lange and Shore. (Received December 13, 2011)

1078-03-369 **Gwyneth F Harrison-Shermoen*** (gwyneth@math.berkeley.edu), Department of Mathematics, University of California, Berkeley, 970 Evans Hall #3840, Berkeley, CA 94720. *Independence relations in NTP1 theories.* Preliminary report.

The theory of infinite dimensional vector spaces with a bilinear form over an algebraically closed field is a non-simple theory without the tree property of the first kind. It also has an independence relation satisfying all the properties of independence relations in stable theories except for local character. (This is by work of Nicolas Granger.) In this talk, I shall explain a possible generalization of this independence relation to other structures that can be viewed as limits of certain substructures with simple theories in the way that this infinite dimensional vector space can be thought of as a limit of its finite dimensional subspaces (over the same field). (Received December 13, 2011)

1078-03-370 **Cameron Donnay Hill*** (cameron.hill.136@nd.edu). *Well-quasi-orders in first-order model theory.*

The notion of well-quasi-ordering plays a key role in many areas of discrete mathematics – especially, in structural graph theory where well-quasi-ordering of finite graphs by the graph-minor relation is the essential ingredient of the Graph Structure Theorem of Robertson and Seymour. I will discuss the role well-quasi-orders of definable sets plays in analyzing quasi-finite axiomatizability and geometrical finiteness (AZ-enumerability) for theories with the finite submodel property. I will also note some connections between well-quasi-orderings of the definable sets of a model and of an associated class of finite structures under an appropriate “strong-substructure” relation. (Received December 13, 2011)

1078-03-375 **Steven C. Leth*** (steven.1eth@unco.edu), School of Mathematical Sciences, University of Northern Colorado, Greeley, CO 80639. *Some questions and answers about “fixed point traps” in the plane.* Preliminary report.

Regions in the nonstandard plane that contain no standard point have previously been investigated by the author with the goal of creating “fixed point traps.”

par

Let E be a standard compact, connected subset of the plane whose complement is also connected. Let f be a standard continuous function from E to E . We are interested in the general problem of finding conditions that can be added to those below that allow us to conclude that f has a fixed point.

- i) D is a connected subset of E and V is a connected open region whose closure contains D .
- ii) V contains no standard points.

iii) The boundary of V , except on an arc A of infinitesimal length, is contained in the complement of *E .

iv) There exists a point $p \in D \cap A$ and an internal topological disk B such that the connected component of $f(p)$ in ${}^*E - B$ is contained in V .

We look at some examples of such conditions and some conjectures and their implications. (Received December 13, 2011)

1078-03-377 **Mia Minnes*** (minnes@math.ucsd.edu). *Algorithmic randomness and complexity via automata.*

Algorithmic randomness is well-studied in the context of Turing machines (effective martingales, Kolmogorov complexity, etc.) We will discuss recent work on randomness with respect to finite-state machines. (Received December 13, 2011)

1078-03-383 **Heinz Weisshaupt*** (heinz.weisshaupt@zbsa.uni-freiburg.de), University of Freiburg, Institute of Mathematics, Eckerstraße 1, Freiburg, D-79104. *A proof theoretic foundation of radically elementary analysis.*

We provide a new approach to nonstandard analysis and give some applications. Although our approach furnishes a classical framework it is related to constructivist/intuitionist ideas. (Received December 13, 2011)

1078-03-388 **Clifton F Ealy and Jana Marikova*** (j-marikova@wiu.edu). *Definable sets in o-minimal fields with convex subrings.*

We let R be an o-minimal field, V a convex subring, and k the corresponding residue field with structure induced from R . Towards answering the question whether the (first order axiomatisable) class of structures (R, V) for which k is o-minimal is a useful generalization of the T-convex case, we show that if k is o-minimal, then the structure on the residue field induced from (R, V) is also o-minimal. Together with a result by Hasson and Onshuus this yields stable embeddedness of the residue field in (R, V) . This is joint work with Clifton Ealy. (Received December 13, 2011)

1078-03-390 **David Lippel*** (dlippel@haverford.edu). *dp-minimality for valued fields.* Preliminary report.

The notion of dp-minimality (introduced by Shelah in 2005) is general enough that an X -minimal theory is dp-minimal for each X in the set {strongly, o, “weakly o”, C , p }. Moreover, dp-minimality does seem to capture something important that is common to all of these settings. I will discuss dp-minimality (and some related notions) specifically in the context of valued fields, generalizing ideas from the proof that p -minimal theories are dp-minimal (which was joint work with Alf Dolich and John Goodrick). (Received December 13, 2011)

1078-03-392 **Matt Insall, Peter A. Loeb and Malgorzata Aneta Marciniak*** (malgorzata.marciniak@utoledo.edu). *Ends from Freudenthal to nonstandard analysis.*

The definition of ends was formally introduced by Freudenthal in 1931. Since that time it went through many modification and was applied in different fields of mathematics, like group theory, analysis, several complex variables, low-dimensional topology, etc. During this talk I will present a selection of concepts related to ends that are significant in nonstandard analysis. (Received December 13, 2011)

1078-03-399 **Joseph S. Miller*** (jmillerm@math.wisc.edu). *Cupping with random sets.*

Antonin Kučera asked if the K -trivial sets could be characterized as those that cannot be cupped above \emptyset' with an incomplete Martin-Löf random. Furthermore, under the assumption that the non- K -trivial is Δ_2^0 , he asked if the incomplete Martin-Löf random cupping partner could also be Δ_2^0 . We answer both in the affirmative.

I will focus on the proof that if A is K -trivial, X is Martin-Löf random, and $A \oplus X$ computes \emptyset' , then X computes \emptyset' . This uses a recent result of Bienvenu, Hölzl, M. and Nies: a Martin-Löf random is complete iff it belongs to a Π_1^0 class in which its lower density is zero. Essentially, by factoring through this result and properties of K -trivials, we can show that X being complete relative to A is the same as X being complete.

The talk describes joint work with Adam Day. (Received December 13, 2011)

1078-03-400 **John M Hitchcock*** (jhitchco@cs.uwo.edu), University of Wyoming, Department of Computer Science, Laramie, WY 82071-3315. *Algorithmic randomness and computational learning.* Preliminary report.

We will survey connections between algorithmic randomness and computational learning, with applications to lower bounds in computational complexity. (Received December 13, 2011)

1078-03-410 **David A Ross*** (ross@math.hawaii.edu), Dept. of Mathematics, University of Hawaii, Honolulu, HI 96822. *Nonstandard measure theory.*

In this talk I will give approximately three applications of nonstandard analysis to measure theory. (Received December 13, 2011)

1078-03-416 **James Freitag*** (freitagj@gmail.com), 2827 W. Belden, Unit 3D, Chicago, IL 60647. *Almost simple differential algebraic groups.*

We will introduce almost simple differential algebraic groups and discuss a question of Phyllis Cassidy and Michael Singer. Model theoretic techniques will be used to resolve some special cases of the question. (Received December 14, 2011)

05 ► *Combinatorics*

1078-05-4 **Lauren K Williams*** (williams@math.berkeley.edu). *Combinatorics of the real Grassmannian and shallow water waves.*

Soliton solutions of the KP equation have been studied since 1970, when Kadomtsev and Petviashvili proposed a two-dimensional nonlinear dispersive wave equation now known as the KP equation. It is well-known that one can use the Wronskian method to construct a soliton solution to the KP equation from each point of the real Grassmannian.

I'll explain how a Deodhar-type stratification of the real Grassmannian allows us to characterize the patterns that appear in these soliton solutions. These patterns can be described using the combinatorics of tableaux, triangulations, permutations, reduced expressions, Go-diagrams, etc. By using these combinatorial tools together with ingredients from total positivity, we are able to solve the inverse problem and the regularity problem for KP solitons from the real Grassmannian.

Regular KP soliton solutions provide a good model for shallow water waves (like beach waves), and I'll end the talk with some pictures. This is joint work with Yuji Kodama. (Received December 10, 2011)

1078-05-48 **Rebecca Garcia***, Department of Mathematics and Statistics, Sam Houston State University, Huntsville, TX 77341-2206. *Construction and enumeration of Franklin magic circles.* Preliminary report.

In several letters written in the mid-1700s, Benjamin Franklin produced his version of magic squares and what he called his “magical circle of circles.” A magic square is an arrangement of numbers in a square grid with rows, columns and diagonals adding to a common number. Similarly, a magic circle is an arrangement of numbers in a circular grid with annuli and radii adding to a common number. In this talk, we will revisit Benjamin Franklin's magic squares of order 8 and 16 and his magic circle of order 8. We will answer various questions on their construction and enumeration using modern techniques derived from computational commutative algebra. Then, we will discuss a method observed by my undergraduate research group who used it to create the only known Franklin magic circle of order 16. (Received November 11, 2011)

1078-05-77 **Persi Diaconis, Jason Fulman*** (fulman@usc.edu) and **Susan Holmes**. *Analysis of casino shelf shuffling machines.*

Many casinos routinely use mechanical card shuffling machines. We were asked to evaluate a new product, a shelf shuffler. This leads to new probability, new combinatorics, and to some practical advice which was adopted by the manufacturer. The interplay between theory, computing, and real-world application is developed. (Received November 21, 2011)

1078-05-83 **Matthias Beck*** (mattbeck@sfsu.edu), Dept. of Math., 1600 Holloway Ave, SF State, San Francisco, CA 94132, and **Benjamin Braun** (benjamin.braun@uky.edu), Department of Mathematics, University of Kentucky, Lexington, KY 40506. *Euler–Mahonian statistics via polyhedral geometry.*

A variety of descent and major-index statistics have been defined for symmetric groups, hyperoctahedral groups, and their generalizations. Typically associated to a pair of such statistics is an *Euler–Mahonian distribution*, a bivariate generating function identity encoding these statistics. We use techniques from polyhedral geometry to establish new multivariate generalizations for many of the known Euler–Mahonian distributions. The original bivariate distributions are then straightforward specializations of these multivariate identities. A consequence of these new techniques is bijective proofs of the equivalence of the bivariate distributions for various pairs of statistics. (Received November 22, 2011)

1078-05-88 **Mirkó Visontai*** (mirko@math.upenn.edu) and **Nathan Williams** (will3089@math.umn.edu). *Stable W -Eulerian polynomials.*

Brenti showed that the Eulerian polynomials of type B have only real roots. In this talk, we strengthen this result. We give a multivariate refinement of these polynomials and show that they are stable, in the sense that they don't vanish whenever the variables have positive imaginary parts.

Our method relies on a refinement of the descent statistic for signed permutations. The key is that our refined multivariate Eulerian polynomials satisfy a recurrence given by a stability-preserving linear operator. The results extend naturally to colored permutations, and generalizations of recent real-rootedness results due to Dilks, Petersen, and Stembridge on affine Eulerian polynomials of types A and C . (Received November 22, 2011)

1078-05-92 **Edward Richmond*** (erichmond@math.ubc.ca), **Marcin Bownik** and **Kurt Luoto**. *Littlewood-Richardson coefficients and tight fusion frames.*

A tight fusion frame is a sequence of orthogonal projection matrices which sum to a scalar multiple of the identity. To any such sequence, we can associate a weakly decreasing sequence of positive integers given by the ranks of these projections. The question we address is the following: For which sequences of positive integers do tight fusion frames exist?

In this talk, I will discuss joint work with K. Luoto and M. Bownik where we explore this problem. In particular, we give a combinatorial characterization in terms of nonvanishing Littlewood-Richardson coefficients. This connection between algebraic combinatorics and frame theory yields several interesting results in both fields of mathematics. (Received November 23, 2011)

1078-05-103 **Adriano M. Garsia*** (garsia@math.ucsd.edu). *Parking functions magics of Macdonald eigen-operators.*

In a 1999 joint paper (Methods and Applications of Analysis, 6 no. 3 (1999) 363-420) we studied a family of operators defined by setting for a symmetric function F

$$\Delta_F \tilde{H}_\mu[X; q, t] = F[B_\mu(q, t)] \tilde{H}_\mu[X; q, t]$$

where $\{\tilde{H}_\mu[X; q, t]\}_\mu$ is the modified Macdonald basis and $B_\mu(q, t)$ is the bi-exponent generator of the Ferrers diagram of μ . In particular, for μ a partition of n we get that $\Delta_{e_n} = \nabla$. In that paper we give a variety of positivity conjectures. Some of these conjectures can now be given a combinatorial interpretation and some time even proved by the discovery that these operators have the power of controlling the combinatorics of Parking Functions to the finest detail. This talk will cover some surprising examples of this phenomenon. (Received November 27, 2011)

1078-05-221 **Greta Panova*** (panova@math.ucla.edu). *Tableaux and plane partitions of truncated shapes.*

We consider a new kind of straight and shifted plane partitions/Young tableaux — ones whose diagrams are no longer of partition shape, but rather Young diagrams with boxes erased from their upper right ends. We find formulas for the number of standard tableaux in certain cases, namely a shifted staircase without the box in its upper right corner, i.e. truncated by a box, a rectangle truncated by a staircase and a rectangle truncated by a square minus a box. The proofs involve finding the generating function of the corresponding plane partitions using interpretations and formulas for sums of restricted Schur functions and their specializations. The number of standard tableaux is then found as a certain limit of this function. The techniques use, among others, polytope volumes, complex integration and RSK. (Received December 09, 2011)

1078-05-276 **Gretchen L Matthews*** (gmatthe@clermson.edu), Department of Mathematical Sciences, Clemson University, Clemson, SC 29634. *On nonbinary parity-check codes.*

Since the mid-1990s, there has been tremendous focus on binary low-density parity-check codes. However, codes over larger alphabets are more suitable for some applications. In this talk, we discuss parity-check codes over \mathbb{F}_p where p is a prime and $p \geq 2$. (Received December 13, 2011)

1078-05-278 **Kento Nakada*** (nakada@wakhok.ac.jp), 1-2290-28 Wakabadai, Wakkanai, Hokkaido 097-0013, Japan. *Uniform generation of standard tableaux for a generalized Young diagram.*

In 1979, C. Greene, A. Nijenhuis, and H. S. Wilf constructed an algorithm which generates standard tableaux for a given Young diagram with uniform probability. This provides a proof of the hook formula for the number of the standard tableaux of a Young diagram, which is originally due to J. S. Frame, G. de B. Robinson, and R. M. Thrall.

In this talk, we explain on a generalization of the result by G-N-W. Our algorithm generates standard tableaux for a given generalized Young diagram with uniform probability. Here, a “generalized Young diagram” is one in the sense of D. Peterson and R. A. Proctor. In terms of Weyl group, a generalized Young diagram corresponds to a *minuscule* element, and a standard tableau to a reduced expression. Similarly, this result provides a proof of the hook formula for the number of the standard tableaux of a generalized Young diagram. (Received December 12, 2011)

1078-05-287 **Jon McCammond*** (jon.mccammond@math.ucsb.edu). *Bounding reflection length in an affine Coxeter group.*

In any Coxeter group, the conjugates of elements in the standard minimal generating set are called reflections and the minimal number of reflections needed to factor a particular element is called its reflection length. In this talk I discuss a recent result with Kyle Petersen uniformly and explicitly bounding the reflection length function on an affine Coxeter group. More precisely we prove that the reflection length function on an affine Coxeter group that naturally acts faithfully and cocompactly on \mathbf{R}^n is bounded above by $2n$ and we also show that this bound is optimal. A complementary recent result by Duszenko shows that spherical and affine Coxeter groups are the only Coxeter groups with a uniform bound on reflection length. (Received December 12, 2011)

1078-05-291 **Steven Klee***, UC Davis Department of Mathematics, One Shields Avenue, Davis, CA 95616. *h-vectors of small matroid complexes.*

In the 1970’s, Stanley conjectured that the h -vector of a matroid simplicial complex is a pure O -sequence. We will present an explicit construction that proves Stanley’s conjecture for all matroids of rank at most three and corank at most two. (Received December 12, 2011)

1078-05-305 **Benjamin Braun, Jonathan Browder*** (browder@math.washington.edu) and **Steven Klee**. *Cointerval simplicial complexes and cellular resolutions.*

In a recent paper, Dochtermann and Engstrom constructed cellular resolutions for hyper-edge ideals of cointerval hypergraphs using a homomorphism complex construction. In this talk I will introduce cointerval simplicial complexes, which generalize cointerval hypergraphs, and discuss how they can be used to obtain cellular resolutions for a new class of ideals, again using a homomorphism complex construction. (Received December 12, 2011)

1078-05-314 **Dave Anderson*** (dandersn@math.washington.edu) and **Linda Chen**. *Equivariant quantum Schubert polynomials.*

Just as the Schur functions represent cohomology classes in the Grassmannian, the Schubert polynomials represent classes in the flag variety. The last two decades have seen generalizations to analogues for equivariant cohomology and quantum cohomology. In this talk, I’ll present joint work with Linda Chen which provides a common generalization of both theories: the “equivariant quantum Schubert polynomials” are polynomials in three sets of variables which represent Schubert classes in equivariant quantum cohomology, and specialize to all the previous versions. Our methods use the geometry of the Quot scheme, and open the way to further applications of the rich combinatorial structure of this space. (Received December 12, 2011)

1078-05-347 **Hwanchul Yoo*** (hcyoo@kias.re.kr), 1530 KIAS 85 Hoegi-ro Dongdaemun-gu, Seoul, 130-722, South Korea. *Specht modules and polytopes*. Preliminary report.

Liu studied Specht modules of forests. He proved that the dimension of the Specht module is the same as the normalized volume of the matching polytope of the forest. To generalize this result, we define a matching ensemble polytope for each pair of a bipartite graph and a certain collection of matchings of the graph. We conjecture that the normalized volume of the polytope equals the dimension of the corresponding Specht module in many cases. We will give evidences that support this conjecture.

In particular, we show that the volume of the polytope for a length $2k$ cycle graph is $k(E_{2k-1} - C_{k-1})$. Here E_{2k-1} is the Euler number that is the number of alternating permutations of length $2k - 1$ and C_{k-1} is the $(k - 1)$ -th Catalan number. We also show how Postnikov’s conjecture on toric Specht module implies that the dimension of the Specht module in this case coincides with $k(E_{2k-1} - C_{k-1})$. This is done by describing the Frobenius character of the module in terms of certain toric tableaux. We conjecture that this description applies for more general diagrams of toric shape. (Received December 13, 2011)

1078-05-396 **Andrew Berget***, Mathematical Sciences Building, One Shields Avenue, Davis, CA 95616, and **Alex Fink**. *Projective equivalence classes of vector configurations.*

We consider the projective equivalence class of an r -by- n matrix v , whose columns are thought of as a vector configuration that realizes a rank r matroid on n elements. The Zariski closure of such an equivalence class is an affine variety that carries the action of a linear algebraic group. In this talk I will discuss invariants of projective

equivalence classes, including equations for these varieties and their K -polynomials. (Received December 13, 2011)

1078-05-414 **Laura Florentina Florescu*** (lara.florescu@gmail.com), PO BOX 1663 D466, Los Alamos, NM 87545. *New connections between the Abelian sandpile model and domino tilings*. Preliminary report.

We examine the connections between the abelian sandpile model and domino tiling. Several original theorems on grid graphs with Klein Four group symmetry are presented, relating the number of symmetric recurrent configurations on grid graphs to the number of domino tilings on different checkerboards. A new proof for the number of tilings on a checkerboard is presented, as well as a partial new proof for the number of tilings on a Möbius checkerboard. We also present a number of other theorems concerning specific graphs, as well as recurrent configurations on grid graphs without symmetry. In exploring grid graphs with dihedral symmetry we find a relation between the number of symmetric configurations and weighted domino tilings on a class of graphs studied in Pachter (1997). Future work involves finding the complete new proof for the number of tilings on a Möbius checkerboard, as well as investigating a group law for the tilings arising from different configurations, inspired by the rotor-router model proposed by Holroyd et al. (Received December 14, 2011)

06 ► Order, lattices, ordered algebraic structures

1078-06-40 **Joel Adler*** (joel.adler@phbern.ch), Gertrud-Woker-Strasse 5, 3012 Bern, Switzerland. *The model companion of the class of pseudocomplemented semilattices is finitely axiomatizable*.

For a class \mathbf{K} of algebras $A(\mathbf{K})$ and $E(\mathbf{K})$ denote its algebraically and existentially closed members. Besides (semantically) determining its members the question whether these classes can be finitely axiomatized is of interest.

In this talk we investigate \mathbf{PCS} , the class of pseudocomplemented semilattices (pcs), in this respect. We will first show how a finite axiomatization of $A(\mathbf{PCS})$ can be obtained using the property: A pcs P is algebraically closed iff every finite subpcs of P can be extended within P to $\underline{2}^r \times (\hat{A})^s$, $\underline{2}$ being the two element Boolean algebra, \hat{A} the countable atomless Boolean algebra with a new top element. This extendability property is described with finitely many first-order sentences.

We will then narrow down existential closedness of a pcs P assuming P is already algebraically closed. A description of this characterization with finitely many formulas together with the above finite axiomatization of $A(\mathbf{PCS})$ gives us the finite axiomatization of $E(\mathbf{PCS})$. (Received November 07, 2011)

1078-06-67 **William J. DeMeo*** (williamdemeo@gmail.com). *Expansions of finite algebras and their congruence lattices*.

We present a novel approach to the construction of new finite algebras and describe the congruence lattices of these algebras. Given a finite algebra $\langle B, \dots \rangle$, let B_1, B_2, \dots, B_K be sets which intersect B at specific points. We construct an *overalgebra* $\langle A, F_A \rangle$, by which we mean an expansion of $\langle B, \dots \rangle$ with universe $A := B \cup B_1 \cup \dots \cup B_K$, and a certain set F_A of unary operations which include idempotent mappings e and e_i satisfying $e(A) = B$ and $e_i(A) = B_i$. We explore a number of such constructions and prove results about the shape of the new congruence lattices $\text{Con} \langle A, F_A \rangle$ that result. Thus, descriptions of some new classes of finitely representable lattices is one contribution. Another, perhaps more significant contribution is the announcement of a novel approach to the discovery of new classes of representable lattices, the full potential of which we have only begun to explore. (Received November 17, 2011)

1078-06-70 **Joel Berman*** (jbberman@uic.edu). *Characterizations of maximal-sized n -generated algebras*. Preliminary report.

For n a positive integer and K a finite set of finite algebras, let $\mathbf{L}(n, K)$ denote the largest n -generated subdirect product whose subdirect factors are algebras in K . For every n and K we provide an upper bound on the cardinality of $\mathbf{L}(n, K)$. This upper bound depends only on n and basic numerical parameters involving the subalgebras, automorphisms and congruence relations of the algebras in K . Let \mathcal{V} denote the variety generated by K . We provide several characterizations of when the free algebra for \mathcal{V} on n free generators has cardinality equal to $|\mathbf{L}(n, K)|$. One characterization is in terms of basic algebraic properties of \mathcal{V} and of the algebras in K . The second involves the term operations for members of K . The third characterization, and the one that will be emphasized in this talk, is based on specific computational tests involving the algebras in K . (Received November 18, 2011)

- 1078-06-140 **Simone Bova*** (simone.bova@vanderbilt.edu) and **Leonardo Cabrer**. *Type classification of unification problems over distributive lattices and varieties of De Morgan algebras.*

The equational unification problem for a variety of algebras is the problem of solving finite systems of equations in the context of free algebras. The solution space of an instance of the unification problem is ordered by generality in a natural way. The (unification) type of an instance is determined by the properties of the set of its solutions of maximal generality.

We classify by type all instances of the unification problem over (bounded) distributive lattices, and over varieties of De Morgan algebras (distributive lattices with an involution satisfying De Morgan laws). The key tool is a characterization of (posets dually equivalent to) finite projective algebras: the correspondence between finite projective distributive lattices and finite nonempty lattices was known; we establish an analogous result for finite projective algebras in De Morgan varieties.

The case of distributive lattices illustrates the idea. If S is an instance of the unification problem (a finite set of lattice equations), and P is the finite poset corresponding to the lattice finitely presented by S , then: If all maximal intervals in P are lattices, and k is the number of such intervals, then S has unitary ($k = 1$) or finitary ($k > 1$) type; otherwise, S has nullary type. (Received December 02, 2011)

- 1078-06-289 **Robert Raphael*** (raphael@alcor.concordia.ca), Mathematics Department, Concordia University, Montreal, Quebec H3G 2T6, Canada. *A lattice naturally associated with a Tychonoff space.* Preliminary report.

Let X be a Tychonoff space. The ring $C(X)$ of continuous functions from X to the reals is well-known to be a lattice. We exhibit a bigger lattice of real-valued functions which is von-Neumann regular, and an epimorphic extension of $C(X)$. The work is related to previous work with Woods and Henriksen. (Received December 12, 2011)

- 1078-06-331 **Peter Jipsen*** (jipsen@chapman.edu), Chapman University, Mathematics, School of Computational Sciences, Von Neumann Hall, 545 W. Palm Ave, Orange, CA 92866, and **Michael A. Moshier**. *A category of contexts dual to complete semilattices with applications to (algebraic) lattices.*

Formal concept analysis represents complete lattices by *contexts*, i.e. triples $X = (X_-, I, X_+)$ such that $I \subseteq X_- \times X_+$ is a binary relation, called the *incidence relation*. While various notions of morphisms have been defined for contexts, we focus on a recent development by M. A. Moshier [1] where a morphism R from X to Y is a binary relation $R \subseteq X_- \times Y_+$ that satisfies a natural compatibility condition. In this setting the category **Cxt** of all contexts is dual to the category **INF** of complete meet-semilattices with completely meet-preserving homomorphisms. We show that the notions of epimorphism, monomorphism and isomorphism have a very simple form in **Cxt**, and we characterize the (non-full) subcategories dual to complete lattices with complete lattice homomorphisms and algebraic lattices with morphisms that preserve arbitrary meets and directed joins. We also discuss the relationship of these dualities with the dualities for lattices by A. Urquhart and by G. Hartung. [1] M. A. Moshier, A relational category of formal contexts, preprint. (Received December 12, 2011)

- 1078-06-404 **Keith A. Kearnes*** (kearnes@euclid.colorado.edu), Department of Mathematics, University of Colorado, Boulder, CO 80309-0395, and **Greg Oman** (goman@uccs.edu), Department of Mathematics, University of Colorado, Colorado Springs, CO 80918. *Posets with small principal ideals and large principal filters.* Preliminary report.

Call a poset P a (κ, λ) -Jónsson poset if it has size λ , any principal ideal has size $< \kappa$, and the complement of any principal filter has size $< \lambda$. We discuss the possible pairs of cardinal numbers, (κ, λ) , for which there is a (κ, λ) -Jónsson poset. We explain the connection with unary Jónsson algebras. (Received December 13, 2011)

08 ► General algebraic systems

- 1078-08-38 **David M. Clark*** (clarkd@newpaltz.edu), Mathematics Department, FOB E1, SUNY, New Paltz, NY 12561. *Evolution of algebraic terms: Term to term operation continuity.*

This work was inspired by recent successful applications of evolutionary computation to the problem of finding terms to represent arbitrarily given operations on a primal groupoid. Evolution requires that small changes in a term result in small changes in the associated term operation. We will present two readily testable conditions under which a finite groupoid is guaranteed to have this continuity property: an algebraic condition and an asymptotic condition. We will show compelling evidence that most primal groupoids satisfy both of these

conditions. We will then display some very large discriminator terms that were found by evolution and are demonstrably not constructible by previously known methods. (Received November 17, 2011)

1078-08-41 **Brian A. Davey*** (B.Davey@latrobe.edu.au) and **Jane G. Pitkethly**. *Counting the relations compatible with an algebra.*

We investigate when a finite algebra admits only a finite number of compatible relations (modulo a natural equivalence). This finiteness condition is closely related to others in the literature, and arises naturally in duality theory. We find necessary conditions for a finite algebra to admit only finitely many compatible relations, as well as a family of examples of such algebras. (Received November 07, 2011)

1078-08-43 **Ralph Freese*** (ralph@math.hawaii.edu). *Congruence semidistributivity and n -permutability.*

Given a set Σ of equations we investigate when the realization of Σ by a variety \mathcal{V} (that is \mathcal{V} satisfies the Maltsev condition for Σ) implies that \mathcal{V} is congruence semidistributive or is congruence n -permutable. This follows the work of Dent, Kearnes and Szendrei who investigated Σ that imply congruence modularity and satisfying a nontrivial congruence identity. Decidability of this process is discussed. (Received November 07, 2011)

1078-08-44 **Walter Taylor*** (walter.taylor@colorado.edu). *Approximate satisfaction of equations on metric spaces.*

We will present some ideas and results concerning the approximate identical modeling of equations Σ by continuous operations on a metric space A . It often happens that A and Σ are *incompatible*, meaning that no continuous operations precisely model Σ on A , and the present investigation hopes to elucidate this phenomenon of incompatibility. We are able in some cases to distinguish two cases: (i) for each $\varepsilon > 0$, there are continuous operations on A modeling Σ within ε , and (ii): the negation of (i).

We also examine the question of whether there are operations F_t exactly modeling Σ on A , such that all the discontinuities of each F_t are smaller than a given ε . (In a sense which we make precise.) (Received November 07, 2011)

1078-08-73 **F. E.J. Linton*** (fejlinton@usa.net), Dept. of Math/CS, Wesleyan Univ., Middletown, CT 06459. *On Iterated Tensor Products in Varieties*. Preliminary report.

Eleven years ago, at a March AMS meeting in Columbia, SC (cf. [1]), I brought up Pierre Grillet's old example (cf. [2]) of three tiny semigroups—bands, all—for which $(A \otimes B) \otimes C$ and $A \otimes (B \otimes C)$ cannot be isomorphic, one being finite while the other is infinite.

Here we go a little further: we exhibit three tiny semigroups—all bands, again (indeed, all the same band)—for which not only is neither of the associations assigning

trilinear maps $\langle A, B, C \rangle \rightarrow X$

to

bilinear maps $\langle A \otimes B, C \rangle \rightarrow X$

or to

bilinear maps $\langle A, B \otimes C \rangle \rightarrow X$

a bijection in general, but the sets of trilinear maps to which those two sorts of bilinear maps give rise need not be the same.

Thus, the two iterated tensor products $(A \otimes B) \otimes C$ and $A \otimes (B \otimes C)$ and a simultaneous three-fold tensor product $A \otimes B \otimes C$ are all fundamentally different one from another, a development that may well leave those with vested interests in the associativity of tensor products reeling.

[1] F.E.J. Linton. *On the Associativity of Tensor Products in non-Entropic Varieties*. A.M.S. Abstract #963-08-201.

[2] Pierre Antoine Grillet. *The Tensor Product of Semigroups*. Trans. Amer. Math. Soc. **138**, 1969, pp. 267-280. (Received November 21, 2011)

1078-08-75 **Benoit Larose*** (larose@mathstat.concordia.ca), Department of Mathematics, Champlain Regional College, 900 Riverside Drive, St-Lambert, QC J4P 3P2, Canada. *Near-unanimity, arc consistency and graph CSPs.*

We investigate the existence of (partially-defined) graph polymorphisms such as near-unanimity and totally symmetric operations and present some interesting consequences for the complexity of various constraint satisfaction problems associated to graphs and digraphs. (Received November 21, 2011)

1078-08-78 **Jennifer Hyndman*** (hyndman@unbc.ca), Department of Mathematics and Statistics, 3333 University Way, Prince George, BC V2N 4Z9, Canada. *Quasi-equations of unary algebras*. Preliminary report.

The original work on finite bases of quasi-equations for unary algebras included a classification of which 3-element unary algebras had a finite basis. Later it was shown that for 3-element unary algebras having a finite basis for the quasi-equations was equivalent to having enough algebraic operations. Having a primitive positive definition of either \leq on a two-element set or of $+\text{ mod } n$ prevents a unary algebra from having a finite basis for its quasi-equations. In contrast, the the table of the clone of operations can sometimes be used to show the existence of a finite basis for the quasi-equations of a unary algebra. The current status of these types of theorems is discussed. (Received November 22, 2011)

1078-08-79 **Alexander Wires***, Department of Mathematics, 1326 Stevenson Center, Vanderbilt University, Nashville, TN 37240. *Definability in the substructure ordering of simple graphs*. Preliminary report.

We explore first-order definability in the poset \mathcal{G} of isomorphism types of finite simple graphs (irreflexive, symmetric) ordered by embeddability. We prove edge-complementation induces the only non-identity automorphism of \mathcal{G} , and that the isomorphism type of each finite simple graph is definable up to this automorphism. Following Jezek and McKenzie (Definability in Substructure Orderings I - IV), we can extend these results to definability in the lattice of universal classes of simple graphs. We then consider the connection between the isomorphism-invariant relations of finite simple graphs definable in the full second-order language, and the first-order definable relations in \mathcal{G} . (Received November 22, 2011)

1078-08-87 **Brian L. Walter*** (bwalter@evergreen.edu), 2700 Evergreen Pkwy NW, Olympia, WA 98505. *Recent work on the finitely based varieties of directed graph algebras*. Preliminary report.

Shallon invented a means of deriving algebras from graphs, yielding numerous examples of so-called graph algebras with interesting equational properties. Our subject is directed graph algebras, derived from directed graphs in the same way that Shallon's graph algebras are derived from graphs. We present recent results about finitely based varieties of directed graph algebras, including some new classes of such varieties and progress toward an answer to the question of whether there are directed graph algebra varieties that are nonfinitely based but not inherently nonfinitely based. (Received November 22, 2011)

1078-08-113 **Matt Valeriote*** (matt@math.mcmaster.ca), Department of Mathematics & Statistics, McMaster University, 1280 Main Street West, Hamilton, Ontario L8S4K1, Canada. *Some new characterizations of some old Maltsev conditions*.

In this talk I will discuss several Maltsev conditions dealing with congruence lattice properties, such as n -permutability and semi-distributivity, that have been studied in the books "The Structure of Finite Algebras", by David Hobby and Ralph McKenzie, and "The Shape of Congruence Lattices" by Keith Kearnes and Emil Kiss. Recently, some new characterizations of these conditions have come to light and during my talk I will present a number of them.

This work is joint Ralph Freese, Marcin Kozik, Andrei Krokhin, Benoit Larose, and Ross Willard. (Received November 29, 2011)

1078-08-245 **Ralph N McKenzie*** (rn.mckenzie@vanderbilt.edu). *Large pseudo-varieties of finite algebras defined by Maltsev conditions*.

Algebras are finite and idempotent, and of one signature σ , which is fixed. A pseudo-variety is a class of these algebras closed under homomorphic images, subalgebras and finite products. A strong pseudo-variety is a pseudo-variety E such that $E \circ E = E$ where "circle" denotes Maltsev product. The equation means that whenever A is an algebra of the signature σ , and A has a congruence θ for which $A/\theta \in E$ and every subalgebra of A constituting a θ -equivalence class belongs to E , then $A \in E$. Day (the class of algebras with Day terms) and Jónsson are not pseudo-varieties, but Taylor and "few subpowers" and $SD(\wedge)$ and $SD(\vee)$ and the class of algebras belonging to an n -permutable variety for some n , are strong pseudo-varieties. We shall discuss some open problems arising from these observations. (Received December 10, 2011)

1078-08-281 **George McNulty** and **Ross Willard*** (rdwillar@uwaterloo.ca), Pure Math Dept, University of Waterloo, Waterloo, Ontario N2L 3G1, Canada. *Meditation on Isaev's algebra*. Preliminary report.

In 1989 I.M. Isaev published (in Russian) a family of finite non-associative bilinear algebras, each of which is inherently nonfinitely based. This family gives essentially the only known example of a finite algebra generating

an inherently nonfinitely based congruence modular variety. After much time and effort, we believe that we finally understand the smallest member of this family, to the point of being able to show that it is inherently nonfinitely based already at the finite level. This shows that “Isaev’s algebra” cannot give an answer to a long-standing question of Eilenberg and Schützenberger. Our proof depends in part on a fine analysis of the equational theory of the ring of lower-triangular 2×2 matrices over $GF(2)$. In this talk some of this stuff will be discussed. (Received December 12, 2011)

1078-08-301 **George F McNulty*** (mcnulty@math.sc.edu), Department of Mathematics, University of South Carolina, Columbia, SC 29208. *The computational complexity of deciding whether a finite algebra generates a minimal variety.* Preliminary report.

In the mid-1950’s Dana Scott pointed out a brute-force algorithm for deciding whether a finite algebra of finite signature generates a minimal variety. This algorithm is very expensive in terms of computational resources. In this talk, I will provide some upper and lower bounds on the computational complexity of this problem and an overview of related open problems. (Received December 13, 2011)

1078-08-405 **Agnes Szendrei*** (szendrei@euclid.colorado.edu). *Separating clones near the top of the clone lattice.* Preliminary report.

Let \mathcal{O} be the clone of all operations on a finite set A with at least three elements. For a finitely generated subclone \mathcal{Q} of \mathcal{O} , the clones $\mathcal{C} (\subseteq \mathcal{O})$ not containing \mathcal{Q} can be best classified by finding a manageable (finite) set R of relations on A such that for every clone $\mathcal{C} (\subseteq \mathcal{O})$ we have $\mathcal{C} \not\supseteq \mathcal{Q}$ iff for some $\rho \in R$ all operations in \mathcal{C} preserve ρ . The aim of the talk is to discuss separation theorems of this kind for some clones \mathcal{Q} near the top of the clone lattice. (Received December 13, 2011)

11 ► Number theory

1078-11-14 **Vinayak Vatsal*** (vatsal@math.ubc.ca), UBC Department of Mathematics, 1984 Mathematics Road, Vancouver, BC V6T 1Z2, Canada. *Some number theory associated to modular forms on $SL(2)$.*

We’ll discuss some more or less well-known results on automorphic forms on $SL(2)$, and give some arithmetic consequences (which may be less well-known). The main idea is to explain how some familiar questions from number theory maybe very naturally formulated in terms of automorphic forms on $SL(2)$, rather than the usual group $GL(2)$ (Received September 19, 2011)

1078-11-17 **Ming-chang Kang*** (kang@math.ntu.edu.tw), Ming-chang Kang, Department of Mathematics, National Taiwan University, Taipei, Taiwan. *Noether’s problem for groups of order p^5 .* Preliminary report.

Let k be any field, G be a finite group acting on the rational function field $k(x_g : g \in G)$ by $h \cdot x_g = x_{hg}$ for any $h, g \in G$. Define $k(G) = k(x_g : g \in G)^G$. Noether’s problem asks whether $k(G)$ is rational (= purely transcendental) over k . It is known that, if $C(G)$ is rational over C , then $B_0(G) = 0$ where $B_0(G)$ is the unramified Brauer group of $C(G)$ over C . Bogomolov showed that, if G is a p -group of order p^5 , then $B_0(G) = 0$. This result was disproved by Moravec for $p = 3, 5, 7$ by computer computing. Without using computers, we will prove two results. Theorem 1. Let p be any odd prime number. Then there is a group G of order p^5 satisfying $B_0(G) \neq 0$. In particular, $C(G)$ is not rational over C . Theorem 2. Let G be a group of order 243 other than $G(243, i)$ where $56 \leq i \leq 60$. Let e be the exponent of G , and k be a field containing a primitive e -th root of unity. Then $k(G)$ is rational over k if and only if $B_0(G) = 0$, i.e. G is not isomorphic to $G(243, i)$ with $28 \leq i \leq 30$ (where $G(243, i)$ is the GAP code number for the i -th group of order 243). (Received October 04, 2011)

1078-11-18 **Florian Luca*** (fluca@matmor.unam.mx), Mathematical Centre UNAM, 58089 Morelia, Michoacan, Mexico. *On a conjecture of Terai.* Preliminary report.

Given positive integers m and r let A and B be such that

$$A + Bi = (m + i)^r \quad (i = \sqrt{-1}).$$

The triple of positive integers (a, b, c) given by $a := |A|$, $b := |B|$ and $c := m^2 + 1$ satisfies $a^2 + b^2 = c^r$, and these integers are coprime when m is even. It turns out that there are only finitely many pairs of positive integers (m, r) with m even such that with the previously constructed (a, b, c) the relation $a^x + b^y = c^z$ holds with some triple of positive integers exponents $(x, y, z) \neq (2, 2, r)$, and furthermore all such pairs (m, r) as well as the corresponding triples of positive integer exponents (x, y, z) are effectively computable, although this presenter

has not computed any explicit upper bound on $\max\{m, r, a, b, c, x, y, z\}$. In the talk, we will survey some known results about the more general conjecture of Terai concerning the Diophantine equation $a^x + b^y = c^z$, and we will outline some of the ideas that go into the proof of the previously mentioned result. (Received September 30, 2011)

1078-11-20 **Olav K Richter*** (richter@unt.edu), **Kathrin Bringmann** and **Martin Raum**.
Kohnen's limit process for real-analytic Siegel modular forms.

Kohnen introduced a limit process for Siegel modular forms that produces Jacobi forms and he asked if there is a space of real-analytic Siegel modular forms such that skew-holomorphic Jacobi forms arise via this limit process. In this talk, I will report on recent joint work with Kathrin Bringmann and Martin Raum. We initiate the study of harmonic skew-Maass-Jacobi forms and harmonic Siegel-Maass forms. We improve a result of Maass on the Fourier coefficients of harmonic Siegel-Maass forms, which allows us to establish a connection to harmonic skew-Maass-Jacobi forms and in particular, to answer Kohnen's question in the affirmative. (Received October 08, 2011)

1078-11-37 **Christopher Davis** (davis@math.uci.edu) and **Kiran S. Kedlaya*** (kedlaya@mit.edu).
On surjectivity of the Witt vector Frobenius.

For p a prime number and R a ring, the p -typical Witt vectors over R form another ring equipped with an endomorphism called Frobenius. If R is of characteristic p , this coincides with the map induced by functoriality from the usual Frobenius map on R . Otherwise, the Witt vector Frobenius is somewhat mysterious; it is never injective, but it is hard to tell whether or not it is surjective. We show that surjectivity of Frobenius per se is rather rare, but that it becomes much more common if we replace infinite Witt vectors with Witt vectors of finite (but arbitrary) length. For instance, we get surjectivity in this sense if R is the ring of integers in any algebraic extension of the rationals containing all roots of unity. This is closely related to such concepts in p -adic Hodge theory as the almost purity theorem of Faltings, which can be generalized (using work of Kedlaya-Liu and Scholze) to a statement with our surjectivity condition as the main hypothesis. One also has analogous statements for big Witt vectors, which may eventually have more global applications. (Received November 03, 2011)

1078-11-42 **David Michael Zureick-Brown*** (david.zureick.brown@gmail.com), 400 Dowman Dr., W430, Atlanta, GA 30322, and **Bryden Cais** and **Jordan Ellenberg**. *Random Dieudonné modules and the Cohen-Lenstra conjectures.*

Knowledge of the distribution of class groups is elusive - it is not even known if there are infinitely many number fields with trivial class group. Cohen and Lenstra's heuristic models the p -part of a class group by a random finite abelian p -group, correctly predicting many strange experimental observations.

While proof of the Cohen-Lenstra conjectures remains inaccessible, the function field analogue - distribution of class groups of quadratic extensions of $\mathbb{F}_p(t)$ - is more tractable. Friedman and Washington modeled the l -power part (with l not p) of such class groups as random matrices and derived heuristics which agree with experiment. Achter later refined these heuristics, and many cases have been proved (Achter, Ellenberg and Venkatesh).

When $l = p$, the l -power torsion of abelian varieties, and thus the random matrix model, goes haywire. I will explain the correct linear algebraic model - Dieudonné modules. Our main result is an analogue of the Cohen-Lenstra/Friedman-Washington heuristics - a theorem about the distributions of class numbers of Dieudonné modules (and other invariants particular to $l = p$). Finally, I'll present experimental evidence supporting our heuristics. (Received November 07, 2011)

1078-11-60 **Jeremy Rouse*** (rouseja@wfu.edu). *Explicit bounds for sums of squares.*

For an even integer k , let $r_{2k}(n)$ be the number of representations of n as a sum of $2k$ squares. The quantity $r_{2k}(n)$ is approximated by the classical singular series $\rho_{2k}(n) \asymp n^{k-1}$. Deligne's bound on the Fourier coefficients of Hecke eigenforms gives that $r_{2k}(n) = \rho_{2k}(n) + O(d(n)n^{\frac{k-1}{2}})$. We determine the optimal implied constant in this estimate provided that either $k/2$ or n is odd. The proof requires a delicate positivity argument involving Petersson inner products. (Received November 15, 2011)

1078-11-61 **Brandt Kronholm*** (jkronhol@whittier.edu), Department of Mathematics, 13406 E. Philadelphia St., Whittier, CA 90608-0634. *New Ramanujan congruence properties of the restricted partition function $p(n, m)$.*

Ramanujan congruences for the unrestricted partition function $p(n)$ are well known and have been studied in great detail. $p(n, m)$ is the restricted partition function that enumerates the number of partitions of n into

exactly m parts. The close relationship between $p(n)$ and $p(n, m)$ is clear:

$$p(n) = p(n, 1) + p(n, 2) + \cdots + p(n, n-1) + p(n, n).$$

Until recently, the existence of Ramanujan-type congruences was virtually unknown for $p(n, m)$. Let ℓ be any odd prime. In this presentation we will establish explicit Ramanujan-type congruences for $p(n, m)$ modulo any prime power ℓ^α . In addition, we will highlight surprising congruence properties for $p(n, m) \pmod{\ell^\alpha}$ for all n . Lastly, we will discuss several intriguing results with regard to m , the number of parts of the partition. (Received November 16, 2011)

1078-11-114 **Jonathan W Sands*** (sands@cems.uvm.edu), Dept. of Mathematics and Statistics, 16 Colchester Ave., Burlington, VT 05401. *L-functions at the origin and annihilation of S-class groups in multiquadratic extensions.*

Fix any Galois extension K/F of number fields with Galois group of exponent 2, and let S be a finite set of primes of F containing the infinite primes and those which ramify in K . We obtain non-trivial annihilators for the S -class group of K from the S -modified equivariant L -function of K/F , regardless of the order of vanishing at the origin. (Received November 29, 2011)

1078-11-124 **Masanobu Kaneko*** (mkaneko@math.kyushu-u.ac.jp), Faculty of Mathematics, Kyushu University, Motooka 744, Fukuoka, 8190395, Japan. *Congruences of Markoff numbers via Farey parametrization.* Preliminary report.

A Markoff number is a natural number that appears in an integer solution to the Markoff equation

$$x^2 + y^2 + z^2 = 3xyz.$$

We first recall a parametrization of Markoff numbers by Farey fractions, due essentially to Frobenius, and prove some congruence properties of Markoff numbers. These congruences can only be formulated by using this particular parametrization.

Our motivation of looking at this parametrization comes from a conjectural behavior of the (regularized) values of the elliptic modular j -function at real quadratic numbers. (Received December 12, 2011)

1078-11-129 **Samuel J Dittmer*** (samuel.dittmer@gmail.com), 865 N 160 W Apt. 124, Provo, UT 84604. *Spoof odd perfect numbers.* Preliminary report.

Since the time of the Greeks, the problem of the existence of odd perfect numbers has remained intractable. There has been surprisingly little theoretical progress, though with the advent of computers, numerical results have made their existence seem increasingly unlikely. A less-known problem is to find spoof odd perfect numbers, a generalization of odd perfect numbers where quasi-prime factorizations are used for the computation of the σ function. For example, Descartes found that, if we treat 22021 as if it were prime, then $198585576189 = 3^2 \cdot 7^2 \cdot 11^2 \cdot 13^2 \cdot 22021$ would be an odd perfect number. To our knowledge, no other spoof odd perfect numbers have been found. Using a computer search, we classify all spoof odd perfect numbers with a given number of distinct quasi-prime factors. This talk reports the results of our search. Our approach and the number-theoretic motivation will also be discussed. (Received December 01, 2011)

1078-11-134 **Zev Klagsbrun, Barry Mazur and Karl Rubin*** (krubin@math.uci.edu). *Ranks of elliptic curves in families of quadratic twists.*

I will discuss some recent results on the distribution of 2-Selmer ranks in families of quadratic twists of elliptic curves over arbitrary number fields. We study the density of twists with a given 2-Selmer rank, and obtain some surprising results on the fraction of twists with 2-Selmer rank of given parity. Since the 2-Selmer rank is an upper bound for the Mordell-Weil rank, this work has consequences for Mordell-Weil ranks in families of quadratic twists. (Received December 01, 2011)

1078-11-135 **Katsuya Miyake*** (miyakek@bz-csp.tepm.jp). *The twists of Hessian elliptic curves over splitting fields of cubic polynomials and the related elliptic 3-folds.*

We give our recent results on the two-parameter family of algebraic curves $\tilde{H}(\mu, t)$ which are twists of Hesse's elliptic curves $U^3 + V^3 + W^3 = 3UVW$ over the splitting fields $\tilde{K}_{\mu, t}$ over $\mathbb{Q}(\mu, t)$ of the cubic generic polynomial $R(t; X) := X^3 + tX + t$ for the symmetric group of degree 3. The twist is defined over $\mathbb{Q}(\mu, t)$ and of genus 1 if a few specific values of the parameters μ and t are excluded. It may not, however, have any rational points over the base field. Here we give a necessary and sufficient condition for the twist to have a rational point over $\mathbb{Q}(\mu, t)$. In the case where the essential part of our sufficient condition is satisfied, we are able to give an elliptic 3-fold over an affine plane from $\tilde{H}(\mu, t)$. If we restrict ourselves to the case where $\tilde{K}_{\mu, t}$ is a cyclic cubic extension of $\mathbb{Q}(\mu, t)$ we also have a necessary and sufficient condition for the twist $\tilde{H}(\mu, t)$ to have a rational

point over $\mathbb{Q}(\mu, t)$, and give another elliptic 3-fold over an elliptic surface which comes out of the essential part of the sufficient condition. (Received December 02, 2011)

1078-11-143 **Alina Bucur*** (alina@math.ucsd.edu), 9500 Gilman Dr #0112, La Jolla, CA 92093. *Point counts for complete intersections over finite fields.*

I will give a quick overview of some new developments in counting points on curves over finite fields. Then we will concentrate on giving a probabilistic model for the number of rational points on a complete intersection of hypersurfaces in projective n -space. A somewhat surprising corollary is that the number of rational points on a random smooth intersection of two surfaces in projective 3-space is strictly less than the number of points on the projective line. This is joint work with K. Kedlaya. (Received December 05, 2011)

1078-11-144 **Marie-Jose Bertin, Amy Feaver, Jenny Fuselier and Matilde Lalin*** (mlalin@dms.umontreal.ca), Mathématiques et statistiques, Université de Montréal, CP 6128, succ. Centre-ville, Montreal, Quebec H3C 3J7, Canada, and **Michelle Manes**. *Mahler measures of some $K3$ surfaces.* Preliminary report.

We study the Mahler measure of the three-variable Laurent polynomial $x + 1/x + y + 1/y + z + 1/z - k$ where k is a parameter. The zeros of this polynomial define (after desingularization) a family of $K3$ -surfaces. In favorable cases, a singular $K3$ -surface is obtained and the Mahler measure is related to its L -function. This was firstly studied by Marie-Jose Bertin. In this talk we present some new formulas. (Received December 03, 2011)

1078-11-146 **Michel L Lapidus*** (lapidus@math.ucr.edu), University of California, Department of Mathematics, Riverside, CA 92521-0135, and **Goran Radunovic** and **Darko Zubrinic**. *Zeta functions associated with general compact sets in R^N : Towards a general theory of complex fractal dimensions.*

We define and study a new family of zeta functions associated with general compact sets in Euclidean spaces of any dimension (or in arbitrary measure metric spaces). In this talk, we focus on the Euclidean setting and show, in particular, that the Minkowski dimension of the compact set is equal to the abscissa of convergence of the associated zeta function, thereby extending to higher dimensions a known result for the one-dimensional case (corresponding to fractal strings, see the books by the presenter and M. van Frankenhuysen on this subject). We illustrate the theory by various examples of fractal sets. We also discuss several open problems in this context and the possible consequences of these definitions and results to help develop a general theory of complex fractal dimensions in higher dimensions. (The complex dimensions are defined as the poles of the meromorphic continuation of the zeta function.) For now, possible connections between the present work and the earlier higher-dimensional theory of complex dimensions of fractal sprays and of self-similar tilings developed by the presenter jointly with E. Pearse (as well as with E. Pearse and S. Winter, *Adv. in Math.*, 2011), via tube formulas and the associated tubular zeta functions, remain to be explored. (Received December 05, 2011)

1078-11-147 **Michel Waldschmidt*** (miw@math.jussieu.fr), Université P. et M. Curie (Paris 6), Institut de Mathématiques de Jussieu, Théorie des Nombres Case 247, 75252 Paris, France. *Families of Thue–Mahler equations with only trivial solutions.*

So far, a very small number of families of Diophantine Thue equations having only nontrivial solutions have been exhibited – explicit families of Thue–Mahler equations having this property were not known. We produce a large collection of examples, including the following one. Let K be a number field, S a finite set of places of K containing the infinite places, and E_S the set of S -units in K of degree ≥ 3 . For $\varepsilon \in E_S$, we denote by $F_\varepsilon(X, Y)$ the irreducible homogeneous form in $\mathbf{Z}[X, Y]$ of degree $[\mathbf{Q}(\varepsilon) : \mathbf{Q}]$ such that $F_\varepsilon(X, 1) \in \mathbf{Z}[X]$ is the irreducible polynomial of ε . Then the set of (x, y, ε) where x and y are S -units in K and ε is in E_S such that $F_\varepsilon(x, y) = 1$ is finite. The proof rests on Schmidt’s Subspace Theorem.

This is joint work with Claude Levesque. (Received December 04, 2011)

1078-11-149 **John Friedlander*** (frdlndr@math.toronto.edu), Dept. of Mathematics, University of Toronto, 40 St. George Street, Toronto, Ontario M1G 3V3, Canada. *The spin of prime ideals.*

For a given number field K with ring of integers \mathcal{O} and a fixed automorphism, we attach to ideals of \mathcal{O} a symbol, the “spin”, which describes the quadratic nature of the ideal relative to its Galois conjugate. We show the equidistribution of the spin when summed over prime ideals. The result is applied to the arithmetic statistics of Selmer groups of elliptic curves. This highlights work joint with H. Iwaniec, B. Mazur and K. Rubin. (Received December 04, 2011)

1078-11-154 **Alexander Abatzoglou**, UCI, Irvine, CA, **Alice Silverberg***, UCI, Irvine, CA, **Andrew V. Sutherland**, MIT, Cambridge, MA, and **Angela Wong**, UCI, Irvine, CA.
Using elliptic curve with CM by $\sqrt{-7}$ to test primality.

We use elliptic curves with complex multiplication by $\mathbb{Q}(\sqrt{-7})$ to test primality for integers of certain forms. This generalizes earlier work of B. Gross and of R. Denomme and G. Savin who dealt with elliptic curves with complex multiplication by $\mathbb{Q}(i)$ and $\mathbb{Q}(\sqrt{-3})$. We implement the test and search for large primes. (Received December 04, 2011)

1078-11-160 **Carl Pomerance***, Mathematics Department, Dartmouth College, Hanover, NH 03784.
The range of Carmichael's function. Preliminary report.

Carmichael's function assigns to a natural number n the order of the largest cyclic subgroup of the unit group mod n . It is nearly as ubiquitous as Euler's function and it seems one should try and understand it as well as possible. In particular, what can be said about its range? After work of Erdős, Schmutz, and myself, we know the number of values in $[1, x]$ is bounded above by a function of the shape $x/(\log x)^c$, with $0 < c < 1$. (It is trivially bounded below by $x/\log x$.) Friedlander and Luca worked out a numerical value of c of about 0.057. In the current project, which is joint with Florian Luca, we improve this value of c to the Erdős–Tenenbaum–Ford constant 0.086..., we give a heuristic that this is best possible, and we rigorously find a lower bound for the count of about $x/(\log x)^{3/5}$. (Received December 05, 2011)

1078-11-172 **Shin-ichi Katayama*** (katayama@ias.tokushima-u.ac.jp), Department of Mathematical Sciences, Faculty of Integrated Arts and Sciences, Tokushima University, Tokushima, 770-8502, Japan. *On finite simple groups of square order.*

In 1980 M. Newman, D. Shanks and H.C. Williams have investigated a new characterization of the order of finite simple groups. They have shown that a symplectic group $S_p(2n, q)$ has a square order if and only if $n = 2$ and $q = p$, where p is a NSW prime in Acta Arithmetica 38 (1980). In that paper, they have raised the following question.

Is there any finite simple group, other than a symplectic group, having order which is a square?

The purpose of this talk is to announce that there are no other finite simple groups which have square orders. To prove this fact, we need the classification of finite simple groups and elementary properties of square terms in binary recurrence sequences. (Received December 05, 2011)

1078-11-181 **Gary Walsh*** (gwalsh@uottawa.ca), Dept Math U.Ottawa, 585 King Edward St, Ottawa, ON K1N 6N5, Canada, and **Alain Togbe** (atogbe@pnc.edu), 1401 S. US 421, Math Dept Purdue University North Central, Westville, IN 46391. *Common terms in Lucas sequences of distinct type.*

We discuss new upper bounds for the number of common terms in two Lucas sequences of distinct type, and some related open problems. (Received December 06, 2011)

1078-11-197 **Robert Osburn*** (robert.osburn@ucd.ie), UCD School of Mathematical Sciences, Room 533, Library Building, Belfield, Dublin, 4, Ireland, and **Jeremy Lovejoy** (lovejoy@liafa.jussieu.fr), LIAFA, Université Denis Diderot-Paris 7, Case 7014, 75205 Paris Cedex 13, 75205, France. *Multisum families of mock theta functions.*

It is now known that each of Ramanujan's mock theta functions is the holomorphic part of a weight $1/2$ harmonic weak Maass form. Following Zagier, the holomorphic part of any weight $1/2$ harmonic weak Maass form is called a mock theta function. In this talk, we discuss an explicit construction of new multisum families of q -hypergeometric series which are mock theta functions (in the modern sense). We also present identities between these new families and classical mock theta functions. This is joint work with Jeremy Lovejoy (Paris 7). (Received December 07, 2011)

1078-11-209 **Hershy Kisilevsky*** (kisilev@mathstat.concordia.ca), Department of Mathematics and Statistics, Concordia University, Montreal, Quebec H3G 1M8, Canada, and **Michael O Rubinstein**. *Chebotarev sets.*

We consider the question of whether a set of prime numbers with rational density can be defined by Chebotarev conditions (Received December 08, 2011)

1078-11-211 **Shichun Yang, Bo He and Alain Togbe*** (atogbe@pnc.edu), 1401 S. U.S. 421, Westville, IN 46391. *Diophantine equations with products of consecutive values of a quadratic polynomial.*

Let a, b, c, d be given nonnegative integers with $a, d \geq 1$. We consider the Diophantine equation

$$\prod_{k=1}^n (ak^2 + bk + c) = dy^l, \quad \gcd(a, b, c) = 1, \quad l \geq 2,$$

where $ax^2 + bx + c$ is an irreducible quadratic polynomial. We will show how one can obtain a computable sharp upper bound to n . Using this bound, we entirely prove some conjectures set by Amdeberhan, Medina and Moll in 2008. Moreover, we will the solutions of other related equations. This is a joint work with B. He and S. Yang. (Received December 08, 2011)

1078-11-224 **Radan Kučera*** (kucera@math.muni.cz). *Annihilators of the class group of an imaginary compositum of quadratic number fields.*

Let k/\mathbb{Q} be an imaginary compositum of quadratic number fields such that 2 does not ramify in k . The aim of the talk is to explain a construction of new explicit annihilators of the class group of k not belonging to the Stickelberger ideal, the usual source of annihilators. These new annihilators are obtained as quotients of some elements of the Stickelberger ideal by suitable powers of 2. (Received December 09, 2011)

1078-11-226 **Cameron L Stewart*** (cstewart@uwaterloo.ca), Department of Pure Mathematics, University of Waterloo, Waterloo, Ontario N2L3G1, Canada. *Exceptional units and cyclic resultants.*

Let α be a non-zero algebraic integer of degree d over the rationals. Put $K = \mathbb{Q}(\alpha)$ and let $O(K)$ denote the ring of algebraic integers of K . We shall discuss estimates for the number of positive integers n for which $\alpha^n - 1$ is a unit in $O(K)$ and for the largest positive integer n for which $\alpha^n - 1$ is a unit for j from 1 to n . (Received December 09, 2011)

1078-11-230 **Andrew Knightly***, Department of Mathematics & Statistics, 5752 Neville Hall, Rm 333, University of Maine, Orono, ME 04469, and **John Jackson**, Department of Mathematics & Statistics, University of Maine. *Average values of twisted L-functions.*

We use the relative trace formula to compute the sum (over cusp forms of a given level and weight) of modular L-functions, twisted by a fixed primitive Dirichlet character, inside the critical strip. When the level or the weight is sufficiently large, the sum is nonzero. (Received December 09, 2011)

1078-11-232 **Arthur Baragar*** (baragar@unlv.nevada.edu), 4505 Maryland Parkway, Box 4020, Las Vegas, NV 89054-4020. *Vector heights.*

In this talk, we discuss the notion of a vector height for a K3 surface – a height from the surface to its Picard group tensored with \mathbb{R} . We discuss the uniqueness of vector heights; their relationship with Weil heights; and the advantage of using vector heights. (Received December 09, 2011)

1078-11-233 **Yūsuke Okuyama*** (okuyama@kit.ac.jp), Division of Mathematics, Graduate School of Science and Technology, Kyoto Institute of Technology, Kyoto 606-8585, Japan. *Quantitative equidistribution in dynamics over general fields.*

Let $\mathbb{P}^1(K)$ denote the Berkovich projective line over an algebraically closed and complete normed field K . Let f be a rational function on $\mathbb{P}^1(K)$ of degree $d > 1$, and μ_f denote the equilibrium measure of f on \mathbb{P}^1 . A quantitative equidistribution

$$\left| \int_{\mathbb{P}^1} \phi d\left(\frac{(f^n)^*(a)}{d^n} - \mu_f\right) \right| = O(\sqrt{nd^{-n}})$$

is obtained for every C^1 test function ϕ and every $a \in \mathbb{P}^1$, except for a subset of capacity 0 in the derived set of acyclic critical orbits of f in \mathbb{P}^1 . The proof is based on estimating the error terms of asymptotic Feketeness of $((f^n)^*(a))$ in terms of the proximity of acyclic critical orbits of f to the initial a .

For a given number field k with a place v , in the arithmetic setting that $K = \mathbb{C}_v$ and that f has its coefficients in k , the dynamics $f : \mathbb{P}^1(\bar{k}) \rightarrow \mathbb{P}^1(\bar{k})$ (\bar{k} is the algebraic closure of k) is also interesting, and using the dynamical Diophantine approximation due to Silverman, and Szpiro and Tucker, the above estimate recovers Favre and Rivera-Letelier's arithmetic estimate on $\mathbb{P}^1(\bar{k})$, in a purely local manner. (Received December 09, 2011)

1078-11-239 **Brian Conrad*** (conrad@math.stanford.edu), Math Dept., Stanford Univ., Bldg 380, Sloan Hall, Stanford, CA 94305, Afghanistan. *Global lifts with local properties.*

We discuss some phenomena related to the problem of lifting a global Galois representation through a central quotient between linear algebraic groups. Even the 1-dimensional case presents some surprises (which ought

to have been discovered long ago, but apparently were not). We illustrate this with some examples, and then discuss the general case. (Received December 10, 2011)

1078-11-246 **Par M. Kurlberg***, Department of Mathematics, KTH, Stockholm, 10044, and **Ben Hutz, Thomas Scanlon, Thomas Tucker, Dragos Ghioca and Robert Benedetto.**
Orbit length statistics and the dynamical Mordell-Lang conjecture.

Let B be a finite set of “bad” points in P^1 . Given a morphism $f : P^1 \rightarrow P^1$, and a starting point x_0 , we wish to find primes p for which the periodic part of the f -orbit, modulo p , does not intersect the bad set. Given a certain plausible “randomness hypothesis” on f , we will show that this happens for essentially all p . However, for the analogous question in higher dimensions (here the set of bad points is the ramification divisor), it turns out that the orbit modulo p is exceedingly likely to intersect the bad set. (Received December 10, 2011)

1078-11-262 **Ernst Kani*** (kani@mast.queensu.ca), Department of Mathematics and Statistics, Queen’s University, Kingston, Ontario K7L 3N6, Canada. *Binary theta series and modular forms of weight one with complex multiplication.*

The main purpose of this talk is to show that the space $\Theta(D)$ generated by the theta series attached to positive definite binary quadratic forms of discriminant D/t^2 (where $t^2|D$, $t \geq 1$) equals the space of modular forms of weight 1 of level $|D|$ which have complex multiplication by their Nebentypus character ψ_D (= Legendre-Kronecker character). (Received December 11, 2011)

1078-11-265 **Driss Essouabri*** (driss.essouabri@univ-st-etienne.fr), Faculte des Sciences et Techniques, Departement de Mathematiques, 23 rue du Docteur Paul Michelon, 42023 Saint-Etienne, France, and **Ben Lichtin** (lichtin@math.rochester.edu). *Zeta functions of discrete self-similar sets II.*

After recalling some properties of discrete self-similar sets and their zeta functions, we will give two applications to these notions. The first one address the Erdos distance problem for increasing families of subsets of a discrete self-similar set. The second application treats a subject in the diophantine approximation of a vector of real algebraic integers. In particular, this second application extends (partially) a classical result of Mahler beyond the case of quadratic irrationalities which he studied. (Received December 11, 2011)

1078-11-266 **Amir Akbary*** (amir.akbary@uleth.ca), Department of Mathematics and Computer Sci., University of Lethbridge, Lethbridge, Alberta T1K 3M4, Canada. *A geometric variant of Titchmarsh divisor problem.*

We formulate a geometric analogue of the Titchmarsh Divisor Problem in the context of elliptic curves and more generally for abelian varieties. For any abelian variety A defined over rationals, we study the asymptotic distribution of the primes which split completely in the division fields of A . (Received December 11, 2011)

1078-11-269 **Toru Komatsu*** (komatsu_toru@ma.noda.tus.ac.jp), 2641 Yamazaki, Noda-shi, Chiba-ken 278-8510. *On inverse Galois problem with certain prime conditions.* Preliminary report.

We solve the inverse Galois problem with certain prime splitting conditions. For a positive integer n let K be a number field with degree n such that every prime divisor of n remains prime in K . It is known that such a field K is non-Galois if n is divisible by 8. We study the Galois group of the Galois closure of such K . Let G be a subgroup of the n th symmetric group S_n containing a permutation of length n . When n is not greater than 8 and G is not the 8th cyclic group C_8 , we prove that there exists a number field K with degree n such that every prime divisor of n remains prime in K and the Galois group of the Galois closure of K is isomorphic to G . We verify the existence of K by an explicit polynomial defining K . (Received December 11, 2011)

1078-11-270 **Chantal David*** (cdavid@mathstat.concordia.ca). *Elliptic curves with a fixed number of points over finite fields and the Cohen-Lenstra Heuristics.*

Let E be an elliptic curve over \mathbf{Q} . We consider the problem of counting the number of primes p for which the reduction of E modulo p possesses exactly N points over the finite field \mathbf{F}_p . On average (over a family of elliptic curves), we show bounds that are significantly better than what is trivially obtained by the Hasse bound (the only known bound for a single elliptic curve). Under an additional hypothesis concerning the short interval distribution of primes in arithmetic progressions, we obtain an asymptotic formula for the average. This average order does not depend only on the size of the integer N , but on some arithmetic properties of N . This seems to be another example of the Cohen-Lenstra heuristics which predict that random groups G occur with probability weighted by $1/\#\text{Aut}(G)$. We also exhibit more occurrences of the Cohen-Lenstra heuristics in this new context

by counting the number of primes where $E(p)$ is isomorphic to a fixed abelian group G . This is joint work with Ethan Smith, CRM, Montréal. (Received December 11, 2011)

1078-11-271 **Hafedh Herichi***, Mathematics department, University of California, Riverside, Riverside, CA 92521. *On the Apollonian integral packing and self-similar tilings.*

On this expository talk, we discuss some of the geometric and analytic fundamental properties of the Apollonian integral packing (AIP). We also introduce the class of self-similar tilings as studied in the work of M. L. Lapidus, E. J. Pearce and S. Winter. We end up the talk presenting an open problem, related to AIP, within the spirit of the theory of complex dimensions in fractal geometry which was developed by M. L. Lapidus and M. v. Frankenhuysen. (Received December 12, 2011)

1078-11-273 **Yu Yasufuku*** (yasufuku@math.cst.nihon-u.ac.jp). *Integral Points and Forward Orbits on \mathbb{P}^n .*

Silverman has proved finiteness of integers in an orbit of a non-totally-ramified morphism on \mathbb{P}^1 . In this talk, we will describe generalizations of this result to maps on \mathbb{P}^n . Some specific low-degree and low-dimensional maps are treated, and we also present, assuming a powerful conjecture by Vojta, a theoretical result treating more general morphisms. (Received December 12, 2011)

1078-11-282 **Dino Lorenzini*** (lorenzini@uga.edu), Department of Mathematics, University of Georgia, Athens, GA 30602. *Torsion and Tamagawa numbers.*

Let A/K be an abelian variety over a global field K . For each place v of K , one associates an integer $c(v)$ called the Tamagawa number of the place, using the reduction of the abelian variety at v . Let c denote the product of the $c(v)$'s. Let t denote the order of the torsion subgroup of Mordell-Weil group $A(K)$. The ratio c/t is a factor in the leading term of the L -function of A/K at $s = 1$ predicted by the conjecture of Birch and Swinnerton-Dyer. We investigate in this talk possible cancellations in the ratio c/t . For elliptic curves over \mathbb{Q} , the smallest ratio c/t is $1/5$, obtained only by the modular curve $X_1(11)$. (Received December 12, 2011)

1078-11-283 **John J Webb*** (webbjj@wfu.edu), Wake Forest University, Department of Mathematics, PO Box 7388, Winston-Salem, NC 27109. *ℓ -adic properties of ℓ -regular partitions.* Preliminary report.

For a positive integer n , we call a non-increasing sequence of positive numbers whose sum is n a partition of n . If none of the parts of a partition is divisible by an integer k , we say the partition is k -regular. Let $\ell \geq 5$ be prime. We adapt the recent techniques developed by Folsom-Kent-Ono to study congruences for ℓ -regular partitions modulo powers of ℓ . In particular we prove analogues of the famed Ramanujan congruences when $\ell \in \{5, 7, 11\}$. (Received December 12, 2011)

1078-11-286 **Machiel van Frankenhuysen*** (vanframa@uvu.edu). *Complex dimensions of Cantor strings and the Riemann zeros.*

After giving an overview of the idea of complex dimension, as conceived by Michel Lapidus and developed with collaborators, I will discuss the special class of Cantor strings. In this class, the spectral operator is invertible, thus yielding that the zeros of the Riemann zeta function do not lie in a vertical arithmetic progression. In closing, I will discuss how a strengthening of this theorem to uniformly finite vertical progressions would yield a zero free region of the Riemann zeta function. (Received December 12, 2011)

1078-11-288 **Jeffrey D. Achter*** (achter@math.colostate.edu), Department of Mathematics, Colorado State University, Fort Collins, CO 80523-1874, and **Clifton Cunningham**. *L -packets and abelian varieties.* Preliminary report.

Let E/\mathbb{Q} be an elliptic curve; it is well known that $a_p(E) = 0$ if and only if the reduction E_p is supersingular. In this talk, I will explain how to interpret the condition " $a_p(E) = 0$ " in terms of the automorphic representation of GL_2 attached to E , and discuss how this situation generalizes to abelian varieties of higher dimension. (Received December 12, 2011)

1078-11-290 **Federico Pellarin*** (federico.pellarin@univ-st-etienne.fr), 23, rue du Dr. Michelon, 42023 Saint-Etienne, France. *On the values at one of certain L -series.*

The values of Riemann's zeta function at even positive integers as well as at negative integers first computed by Euler, with the double appearance of Bernoulli numbers and the occurrence of the number π , suggest the structure of the functional equation of this function. In the arithmetic of function fields of positive characteristic there is a variant of Riemann's zeta function and a large spectrum of phenomena similar to Euler's first observations. In spite of this, no analogue of the functional equation of Riemann's zeta is available. In this talk we provide

some new evidences that such functional equations should exist and some idea of the shape that gamma factors should have. (Received December 12, 2011)

1078-11-292 **Imin Chen*** (ichen@sfu.ca), Department of Mathematics, Simon Fraser University, Burnaby, BC V5A1S6, Canada, and **Yoonjin Lee** (yoonjin1@ewha.ac.kr), Department of Mathematics, Ewha Womans University, Seoul, 120-750, South Korea. *Explicit ramification bounds for division fields of Drinfeld modules.*

I will survey a number of results and applications, obtained with Yoonjin Lee, relating to the problem of explicitly bounding the different divisor of division fields of Drinfeld modules. In rank 2, this involves a detailed study of the Newton polygon and coefficients of the exponential functions associated to a Drinfeld module, making explicit the work developed by Gardeyn. For general rank, we provide a weaker substitute, and then apply both to the problem of obtaining explicit and partially explicit isogeny theorems for Drinfeld modules. (Received December 12, 2011)

1078-11-297 **Riad Masri***, Department of Mathematics, Texas A&M University, College Station, TX 77843-3368, and **Sheng-Chi Liu**. *On the average value of the divisor function.*

We will discuss the asymptotic evaluation of a smooth average of the classical divisor function over values of a quadratic polynomial. We will explain how such a result can be used to study the first moment of certain Rankin-Selberg L -functions. This is joint work with Sheng-Chi Liu. (Received December 12, 2011)

1078-11-312 **Frank H Thorne*** (thorne@math.sc.edu). *Progress on counting discriminants of cubic fields.* Preliminary report.

I will report on my ongoing work on counting discriminants of cubic fields, including joint projects with Manjul Bhargava, Henri Cohen, Anna Morra, and Takashi Taniguchi. (Received December 12, 2011)

1078-11-322 **Rachel J. Pries*** (pries@math.colostate.edu) and **Colin Weir** (cjweir@ucalgary.ca). *Jacobians of Hermitian curves and the supersingular locus.* Preliminary report.

The Dieudonné module of the p -torsion group scheme is a fundamental invariant of an abelian variety in characteristic $p > 0$. There are very few cases in which the Dieudonné module of the Jacobian of a curve is known. One exception is the Hermitian curve $y^p + y = x^{p+1}$, whose Jacobian is well-known to be superspecial; equivalently, its Jacobian is isomorphic to a product of supersingular elliptic curves. For a prime power $q = p^n$ with $n \geq 2$, the Hermitian curve $H_q : y^q + y = x^{q+1}$ is no longer superspecial, but is still supersingular; equivalently, its Jacobian $\text{Jac}(H_q)$ is isogenous to a product of supersingular elliptic curves.

We determine the Dieudonné module of $\text{Jac}(H_q)$ for all prime powers $q = p^n$ using the $k[F, V]$ -module structure of the de Rham cohomology of H_q . The indecomposable factors of the Dieudonné module have a surprising combinatorial structure; while their multiplicities depend on p , the structure of each indecomposable factor does not. This result has several applications: it yields constraints on the decomposition of $\text{Jac}(H_q)$ up to isomorphism; and it gives information about the intersection of the Ekedahl-Oort strata with the supersingular locus of the moduli space of abelian varieties. (Received December 12, 2011)

1078-11-328 **Seok Ho Jin*** (archimed@postech.ac.kr), Hyoja-dong, Pohang, Kyeongsangbook-do, South Korea, **Su Bong Lim** (subong@postech.ac.kr), Hyoja-dong, Pohang, Kyeongsangbook-do, South Korea, and **Youngju Choie** (yjchoie@gmail.com), Hyoja-dong, Pohang, Kyeongsangbook-do, South Korea. *On regularizing the imaginary Doi-Naganuma lifting.*

Let K be an imaginary quadratic field. There is a map, the Doi-Naganuma lifting, taking classical Maass wave forms with respect to a congruence subgroup of $SL_2(\mathbb{Z})$ to modular forms for K . The aim of this paper is to extend this lifting to weak Maass forms and to construct automorphic objects with singularities on the quaternionic upper half-plane \mathfrak{H}^1 .

The main tool we use is Harvey and Moore's extension of the Howe(or theta) correspondence to automorphic forms with singularities, which is called the regularized theta lifting. In this paper we'll mainly follow the arguments of Borcherds and Bruinier to apply this technique, to extend the lifting to the scope of weak Maass forms.

The main part of this paper will be about the convergence. In this paper we also determined the locations of the singularities and their singularity types. (Received December 12, 2011)

1078-11-340 **K James*** (kevja@clemsun.edu), Department of Mathematical Sciences, Clemson University, BOX 340975, Clemson, SC 29634-0975. *The distribution of the traces of Frobenius for elliptic curves.*

Let $E : y^2 = x^3 + Ax + B$ be an elliptic curve over \mathbb{Q} and consider its reduction modulo p . Hasse's theorem says that the number of points on this curve over \mathbb{F}_p is within $2\sqrt{p}$ of $p + 1$. We define $a_E(p) = p + 1 - \#E(\mathbb{F}_p)$. In this talk we will consider questions related to the distribution of $a_E(p)$ as p varies over the set of rational primes. (Received December 13, 2011)

1078-11-341 **Robert J Lemke Oliver*** (rlemke@emory.edu). *Pretentiously detecting power cancellation.*

Granville and Soundararajan have recently introduced the notion of pretentiousness in the study of multiplicative functions of modulus bounded by 1, essentially the idea that two functions which are similar in a precise sense should exhibit similar behavior. It turns out, somewhat surprisingly, that this does not directly extend to detecting power cancellation - there are multiplicative functions which exhibit as much cancellation as possible in their partial sums that, modified slightly, give rise to functions which exhibit almost as little as possible. We develop two new notions of pretentiousness under which power cancellation can be detected, one of which applies to a much broader class of multiplicative functions. This work is joint with Junehyuk Jung. (Received December 13, 2011)

1078-11-344 **kathrin Bringmann*** (kbringma@math.uni-koeln.de), Cologne, Germany. *Locally harmonic Maass forms and rational period functions.*

In this talk we introduce a new type of modular object and construct explicit examples of functions of this type. Our functions are closely related to cusp forms constructed by Zagier which played an important role in the construction by Kohnen and Zagier of a kernel function for the Shimura and Shintani lifts between half-integral and integral weight cusp forms. Although our functions share many properties in common with harmonic weak Maass forms, they also have some properties which strikingly contrast those exhibited by harmonic weak Maass forms. As a first application of the new theory developed in this paper, one obtains a new proof of the fact that the even periods of Zagier's cusp forms are rational as an easy corollary. (Received December 13, 2011)

1078-11-346 **Wai Kiu Chan, Anna Haensch and Benjamin Robert Kane*** (bkane@mi.uni-koeln.de), Nauheimerstrasse 7, 50969 Cologne, Nordr.-Wes, Germany. *Representations by triangular, square, and pentagonal sums.* Preliminary report.

Fermat claimed that all positive integers are represented by 3 triangular numbers, 4 squares, 5 pentagonal, . . . , and m m -gonal numbers. Its determination in the cases $m = 4$ (resp. $m = 3$) was celebrated work of Lagrange (resp. Gauss) and the full conjecture was finally resolved by Cauchy in 1813. In this talk, we will discuss the related question of which "weighted sums" represent all but finitely many positive integers, with a focus on complications which first arise in the $m = 5$ case. This is based on ongoing joint work with W.K. Chan and A. Haensch. (Received December 13, 2011)

1078-11-359 **Jim Brown*** (jim1b@clemsun.edu), Department of Mathematical Sciences, Clemson University, Clemson, SC 29634, and **Krzysztof Klosin** (krzysztof.klosin@qc.cuny.edu). *The CAP ideal and applications.*

Given an automorphic form on $\mathrm{GSp}(4)$ that is CAP with respect to the Siegel parabolic, one can define an associated CAP ideal that measures congruences between this automorphic form and non-CAP forms. This ideal is analogous to the Eisenstein ideal in the $\mathrm{GL}(2)$ theory. We will discuss the definition of this ideal as well as some applications to bounding certain Selmer groups. The results on Selmer groups are analogous to the recent results of Skinner-Urban where they use the Klingen-Eisenstein ideal to produce their results. (Received December 13, 2011)

1078-11-364 **Katherine E Stange*** (stange@math.stanford.edu), Stanford University Mathematics, 450 Serra Mall, Bldg 380, Stanford, CA 94305. *Integral points on elliptic curves and explicit valuations of division polynomials.*

Assuming Lang's conjectured lower bound on the heights of non-torsion points on an elliptic curve, we show that there exists an absolute constant C such that for any elliptic curve E/\mathbb{Q} and non-torsion point $P \in E(\mathbb{Q})$, there is at most one integral multiple $[n]P$ such that $n > C$. The proof is a modification of a proof of Ingram giving an unconditional but not uniform bound. The new ingredient is a collection of explicit formulæ for the sequence $v(\Psi_n)$ of valuations of the division polynomials. For P of non-singular reduction, such sequences are already well described in most cases, but for P of singular reduction, we are led to define a new class of sequences called *elliptic troublemaker sequences*, which measure the failure of the Néron local height to be quadratic. As

a corollary in the spirit of a conjecture of Lang and Hall, we obtain a uniform upper bound on $\widehat{h}(P)/h(E)$ for integer points having two large integral multiples. (Received December 13, 2011)

1078-11-366 **Patrick Ingram*** (pingram@math.colostate.edu), Department of Mathematics, Colorado State University, Fort Collins, CO 80521. *Heights and post-critically finite rational maps.*

In complex holomorphic dynamics, the orbits of critical points reveal much about the behaviour of a map under iteration. Rational functions of a single variable for which all of these critical orbits are finite, then, have a special status. This talk will survey some recent results on the arithmetic of these maps, with an emphasis on the role of heights in their study. (Received December 13, 2011)

1078-11-367 **Christelle Vincent*** (vincent@math.wisc.edu), Department of Mathematics, 480 Lincoln Drive, Madison, WI 53706. *Weierstrass points on the Drinfeld modular curve $X_0(p)$.* Preliminary report.

For q a power of a prime, consider the ring $\mathbb{F}_q[T]$. Due to the many similarities between $\mathbb{F}_q[T]$ and the ring of integers \mathbb{Z} , we can define for $\mathbb{F}_q[T]$ objects that are analogous to elliptic curves, modular forms, and modular curves. In particular, for \mathfrak{p} a prime ideal in $\mathbb{F}_q[T]$, we can define the modular curve $X_0(\mathfrak{p})$, and study the reduction modulo \mathfrak{p} of its Weierstrass points, as is done in the classical case by Rohrlich, and Ahlgren and Ono. In this talk we construct a Drinfeld modular form for $\Gamma_0(\mathfrak{p})$ whose divisor is supported at the Weierstrass points of $X_0(\mathfrak{p})$, and some partial results on the reduction modulo \mathfrak{p} of this divisor are obtained. (Received December 13, 2011)

1078-11-373 **Manfred Kolster*** (kolster@mcmaster.ca), McMaster University, Dept. of Mathematics and Statistics, 1250 Main St W, Hamilton, ON L8S 4K1, Canada. *Brauer-Kuroda relations for motivic cohomology groups.*

Brauer-Kuroda relations describe relations between zeta-functions of number fields. Classically, they induce non-trivial relations between class numbers and regulators. We use the motivic version of the Lichtenbaum Conjecture to discuss similar relations between motivic cohomology groups. (Received December 13, 2011)

1078-11-378 **Brett A. Tangedal*** (batanged@uncg.edu). *Computing Stark units p -adically via a formula of Gross.*

We will present the first systematic computations verifying a p -adic conjecture of "Stark-type" put forth by B. Gross in 1981. These verifications rely upon a recent theorem due to Kashio as well as a new formula discovered by us that allows for the efficient computation of p -adic multiple log gamma functions. This is joint work with Paul Young. (Received December 13, 2011)

1078-11-380 **Kathrin Bringmann, Alexander Holroyd and Karl Mahlburg*** (mahlburg@math.lsu.edu), Lockett Hall 228, Department of Mathematics, Baton Rouge, LA 70803, and **Masha Vlasenko**. *Asymptotic formulas for overpartitions with k -runs.* Preliminary report.

Integer partitions without runs have recently been studied by Andrews from a combinatorial perspective, and also Holroyd, Liggett, and Romik, who described striking connections to probabilistic bootstrap percolation models. In this talk I will discuss recent work on overpartitions with runs, which are a close analogy. We find the asymptotic behavior of such overpartitions by using the Constant Term Method, transformations of theta functions, and the Saddle Point Method. (Received December 13, 2011)

1078-11-387 **Holly Swisher*** (swisherh@math.oregonstate.edu), Department of Mathematics, Kidder Hall 368, Oregon State University, Corvallis, OR 97331, and **Sharon Garthwaite**, **Soon-Yi Kang** and **Stephanie Treneer**. *Mock and false theta functions arising from eta-quotients.*

In a recent paper, Lemke-Oliver classifies those eta-quotients which are theta functions. Using work of Zwegers, for each of the weight $1/2$ eta-quotients $f(\tau)$ listed by Lemke-Oliver we construct a set of mock theta functions with shadow $f(\tau)$. Here, we investigate the mock theta function and shadow pairs, and in particular their false theta counterparts. (Received December 13, 2011)

1078-11-418 **YoungJu Choie*** (yjc@postech.ac.kr), Dept of Mathematics, POSTECH, Pohang, Kyungbuk, South Korea. *Periods and Jacobi forms.* Preliminary report.

In this talk we discuss various connection among Jacobi forms, period of modular forms and Harmonic Maass forms. (Received December 14, 2011)

12 ► *Field theory and polynomials*

1078-12-151 **Jan Minac*** (jminac1811@gmail.com), The University of Western Ontario, Department of Mathematics, Middlesex College, London, Ontario N6A 5B7, Canada, and **Sunil K. Chebolu** and **Ido Efrat**. “*Toy Galois groups and their invariants*”.

When a child plays with his toys, he/she enjoys their resemblance to the real thing, yet this same child enjoys the fact that these toys are manageable. There are indeed such toy Galois groups whose invariants however, are real and meaningful. They can detect some interesting valuations on fields, Witt rings of quadratic forms and Galois cohomology.

I will discuss these Galois groups and possible games one may play with them.

This is joint work with Sunil Chebolu and Ido Efrat. (Received December 04, 2011)

14 ► *Algebraic geometry*

1078-14-32 **Jonathan Lubin*** (lubinj@math.brown.edu), 626 N Michigan Ave, Pasadena, CA 91106-1135. *General dispersion and condensation in Nottingham*.

By the “Nottingham group” we understand the set of series $xg(x)$ over a finite field, with $g(0) = 1$, the group law being given by composition of power series. This note places in a broader context the familiar homomorphism defined on the Nottingham group that takes $xg(x)$ to $xg(x^m)^{1/m}$, m being any positive integer prime to the characteristic. As consequence, one gets a partial but still informative description of the normalizer and centralizer in Nottingham of any finite subgroup. (Received November 01, 2011)

1078-14-45 **S Koike, T-C Kuo** and **L Paunescu*** (laurent@maths.usyd.edu.au), The University of Sydney, Sydney, NSW 2006, Australia. *A’Campo curvature bumps near a singular point*.

Let $f(x, y) \in \mathbb{R}\{x, y\}$ be a real analytic function-germ, $f(0, 0) = 0$. The level curves $f = c$, $0 < |c| < \epsilon$, have “bumps” near 0, as we all know.

Let us consider two simple examples:

$$f_2(x, y) = \frac{1}{2}x^2 - \frac{1}{3}y^3, \quad f_4(x, y) = \frac{1}{4}x^4 - \frac{1}{5}y^5.$$

We all know $f_2(x, y) = c$ attains maximum curvature when crossing the y -axis. However, a profound observation of N. A’Campo is that this is rather an isolated case. For example, the curvature of $f_4 = c$ is actually 0 on the y -axis; the maximum is attained instead as the level curve crosses $x = \pm ay^{4/3} + \dots$, $a \neq 0$ a certain constant.

In this paper we explore this idea in the complex and the real cases, using the language of *Newton-Puiseux infinitesimals* and the notion of “*gradient canyon*”. As we shall see $x = \pm ay^{4/3} + \dots$ are “*infinitesimals*” lying in a gradient canyon, at each of which $f_4(x, y)$ has an “*A’Campo (curvature) bump*”. (Received November 09, 2011)

1078-14-126 **Donal B O’Shea*** (doshea@mtholyoke.edu), Mathematics Dept, Mount Holyoke College, South Hadley, MA 01075. *Exceptional lines, separating sets and vanishing topology at singular points of complex surfaces*. Preliminary report.

Let $(V, p) \subset (\mathbb{C}^3, 0)$ be a surface with isolated singularity at 0. The *Nash fiber* at p (which is defined as the limit of the tangent spaces to V at smooth points $x \in V$ as x tends of p) is known to consist of the Nash fiber of the Zariski tangent cone $(CV, 0)$ (that is, all limits of tangent spaces to the reduced tangent cone) together with finitely many, possibly zero, pencils of planes whose axes are lines in CV through 0 called *exceptional lines*. A *separating set* is a three-dimensional semi-algebraic subset with real tangent cone at 0 of real dimension less than three. We show that the tangent cone to the separating set lies in an exceptional line and give examples showing that for cyclic quotient singularities, the separating sets are topologically (but not geometrically) cones over splitting tori in the link of (V, p) . The splitting tori figure in Birbrair, Neumann and Pichon’s thick-thin decomposition of the link. (Received December 01, 2011)

1078-14-130 **Anatoly Libgober*** (libgober@math.uic.edu), Dept. of Mathematics, UIC, 851 S.Morgan., Chicago, IL 60607. *Stratifications and topological invariants of singular hypersurfaces*.

This is report on joint work with L.Maxim. As part of program of finding invariants specifying topological type of singular hypersurfaces and complete intersections, we express the difference between the Hodge polynomials

of the singular and resp. generic member of a pencil of hypersurfaces in a projective manifold by using a stratification of the singular member described in terms of the data of the pencil. I also will describe explicit examples of such invariants of pencils for surfaces of low degree. (Received December 01, 2011)

1078-14-153 **Paolo Aluffi***, Mathematics Department, Florida State University, Tallahassee, FL 32306.
Chern classes of complements of free divisors.

In previous work we have conjectured that, under suitable hypotheses, the total Chern class of the bundle of logarithmic derivations of a free divisor equals the Chern-Schwartz-MacPherson class of the complement of the divisor. We will discuss counterexamples (due to Xia Liao) to a strong form of this statement, and review cases for which the equality is known to hold. (Received December 04, 2011)

1078-14-171 **Mark Gross*** (mgross@math.ucsd.edu), **Ludmil Katzarkov** and **Helge Ruddat**.
Towards mirror symmetry for varieties of general type.

We give a proposal for mirrors of general type varieties. In the context considered here, we look at mirrors to hypersurfaces S of dimension d in smooth toric varieties lying in ample linear systems. We construct a mirror \tilde{S} of the same dimension; this in general a reducible scheme, which comes along with a perverse sheaf $\mathcal{F}_{\tilde{S}}$. After defining suitable Hodge numbers, we are able to prove the expected identity $h^{p,q}(S) = h^{d-p,q}(\mathcal{F}_{\tilde{S}})$. This suggests that by broadening the category in which we consider possible mirrors to live, there will be a useful theory of mirror symmetry for such varieties. (Received December 05, 2011)

1078-14-251 **Dragos Oprea*** (doprea@math.ucsd.edu), 9500 Gilman Drive #0112, La Jolla, CA 92103, and **Alina Marian**. *Bundles of generalized theta functions and tautological classes.*
Preliminary report.

I will discuss the bundles of generalized theta functions arising from moduli spaces of sheaves over K3 and abelian surfaces, emphasizing connections with strange duality and the study of tautological classes. (Received December 10, 2011)

1078-14-260 **Sean Timothy Paul*** (stpaul@math.wisc.edu), Mathematics Dept. University of Wisconsin, 480 Lincoln Drive, Madison, WI 53706. *K-energy maps and the stability of projective varieties.*

One of the main problems in complex geometry is to detect the existence of "canonical" Kahler metrics in a given Kahler class on a compact complex (Kahler) manifold. In particular one seeks necessary and sufficient conditions for the existence of a Kahler Einstein metric on a Fano manifold. In this case the presence of positive curvature makes this problem extremely difficult and has led to a striking series of conjectures—the "standard conjectures"—which relate the existence of these special metrics (which are solutions to the complex Monge-Ampere equation, a fully non-linear elliptic p.d.e.) to the algebraic geometry of the pluri-anticanonical images of the manifold. Yau speculated that the relevant algebraic geometry would be related (somehow) to Mumford's Geometric Invariant Theory. Eventually it was conjectured that K-energy bounds along Bergman potentials could be deduced from an appropriate notion of "semi-stability". Recently this conjecture has been completely justified by the speaker, building upon work of Gang Tian and Gelfand-Kapranov-Zelevinsky -Weyman. It is the aim of this talk to outline progress on the standard conjectures and to discuss the entire theory in the context of complex algebraic groups and dominance of rational representations of such groups. (Received December 11, 2011)

1078-14-294 **Dagan Karp*** (dk@math.hmc.edu) and **Dhruv Ranganathan** (dhruv_ranganathan@hmc.edu). *Gromov-Witten theory of $\mathbb{P}^1 \times \mathbb{P}^1 \times \mathbb{P}^1$.*

We prove equality between sectors of the all-genus Gromov-Witten theories of $\mathbb{P}^1 \times \mathbb{P}^1 \times \mathbb{P}^1$ and \mathbb{P}^3 and various of their toric blowups. These spaces are either related via birational map, such as the base spaces, or crepant birational map, such as their blowups at points, or simply via blowup, as $\mathbb{P}^1 \times \mathbb{P}^1 \times \mathbb{P}^1$ and the permutohedral variety. As a result, we also prove a nontrivial toric symmetry of $\mathbb{P}^1 \times \mathbb{P}^1 \times \mathbb{P}^1$ which descends from the permutohedral variety. This is joint work with Dhruv Ranganathan. (Received December 12, 2011)

1078-14-310 **Tommaso de Fernex*** (defernex@math.utah.edu) and **Roi Docampo**. *Jacobian discrepancies and rational singularities.*

Singularities in the minimal model program have an asymptotic nature built in. In this paper, we propose a non-asymptotic approach to singularities of arbitrary varieties from the point of view of Jacobian ideals and Nash blow-ups. The main contribution is a theorem establishing the connection between the discrepancies introduced in this context and the notions of rational and Du Bois singularities. (Received December 12, 2011)

1078-14-362 **Dustin J Ross*** (ross@math.colostate.edu), 1610 Westbridge Dr. J53, Fort Collins, CO 80526. *Open GW theory and the orbifold vertex.*

Recent developments in open GW theory of toric orbifolds have led to the formulation of an orbifold topological vertex in GW theory, a basic building block for the GW theory in all genera of toric Calabi-Yau 3-folds. Naturally, our formalism conjecturally coincides with the DT orbifold vertex of Bryan, Cadman, and Young. I will describe the correspondence and mention results in this direction. (Received December 13, 2011)

1078-14-401 **Christopher A Manon*** (chris.manon@math.berkeley.edu), 1205 Melville Square, 408, Richmond, CA 94804. *Phylogenetic trees and the tropical geometry of flag varieties.* Preliminary report.

We will discuss some recent theorems relating the space of weighted phylogenetic trees to the tropical geometry of flag varieties. We review some work of Speyer and Sturmfels, showing that the tropical variety $tr(I_{2,n})$ of the Grassmannian $Gr_2(\mathbb{C}^n)$ is homeomorphic to the space \mathcal{T}^n of weighted phylogenetic trees on n leaves. This work was generalized by Iriarte-Giraldo and the author, who showed that the space \mathcal{T}^n maps into the tropical variety of each Grassmannian variety $Gr_m(\mathbb{C}^n)$ via a collection of functions from the theory of phylogenetics called dissimilarity functions. We will explain how this proof works, and its connection to the combinatorial representation theory of the general linear group $GL_n(\mathbb{C})$. Then we show how to generalize this theorem to arbitrary type A flag varieties, where the role of the dissimilarity functions is played by the tropicalization of the standard monomials for type A . We close with some remarks on how to generalize this story to realize the crystal basis of a simply-connected simple group $G(\Gamma)$ associated to a Dynkin diagram Γ as functions on a combinatorial object called the Bergman fan $B(\Gamma)$, studied by Ardila, Reiner, and Williams. (Received December 13, 2011)

1078-14-411 **Jonathan Wise*** (jonathan@math.stanford.edu), 450 Serra Mall, Bldg 380, Stanford, CA 94305. *Deformation theory and Grothendieck topologies.*

To probe the infinitesimal structure of a moduli space of geometric objects, one seeks to understand families of those objects over “fat points.” Remarkably, these deformation problems tend to admit cohomological solutions of a common form: obstructions in H^2 , deformations in H^1 , and automorphisms in H^0 . I will offer an explanation for this common form, coming from some exotic Grothendieck topologies. We will see how this point of view works in several examples. No prior knowledge about Grothendieck topologies or deformation theory will be assumed. (Received December 14, 2011)

1078-14-413 **Dan Abramovich, Steffen Marcus*** (marcus@math.utah.edu) and **Jonathan Wise.** *A comparison theorem for relative Gromov-Witten theories.*

The Gromov–Witten (GW) theory of a smooth variety X relative to a smooth divisor D gives a virtual count of curves in X with prescribed tangency conditions along D . In the algebraic setting, relative GW invariants have been defined using Jun Li’s moduli space of relative stable maps parameterizing maps into expansions. More recent variants have introduced orbifold techniques and logarithmic structures. In this talk I will describe a theorem comparing several different ways of defining relative GW invariants. This is joint work with Dan Abramovich and Jonathan Wise. (Received December 14, 2011)

1078-14-415 **Colin J Ingalls***, cingalls@unb.ca, and **Alexander Kuznetsov.** *Double covers of \mathbb{P}^3 and Reye congruences.*

We consider the class of singular double coverings $X \rightarrow \mathbb{P}^3$ ramified in the degeneration locus D of a family of 2-dimensional quadrics. These are precisely the quartic double solids constructed by Artin and Mumford as examples of unirational but nonrational conic bundles. With such quartic surface D one can associate an Enriques surface S which is the factor of the blowup of D by a natural involution acting without fixed points (such Enriques surfaces are known as nodal Enriques surfaces or Reye congruences). We show that the nontrivial part of the derived category of coherent sheaves on this Enriques surface S is equivalent to the nontrivial part of the derived category of a minimal resolution of singularities of X . (Received December 14, 2011)

1078-14-417 **Daniel Erman*** (erman@umich.edu), University of Michigan, Department of Mathematics, Ann Arbor, MI 48104, and **Melanie Matchett Wood.** *The probability that a curve over a finite field is smooth.* Preliminary report.

Given a surface over a finite field, we ask what proportion of curves in that surface are smooth. Poonen’s work on Bertini theorems over finite fields answers this question for families of curves derived from a very ample divisor and its powers. In this ample case, the probability of smoothness is predicted by a simple heuristic assuming that smoothness is independent at different points in the surface. We consider this question for more general families of curves. Although the simple heuristic of independence fails, the answer can still be determined and

follows from a richer heuristic that predicts at which points smoothness is independent and at which points it is dependent. This is joint work with Melanie Matchett Wood. (Received December 14, 2011)

16 ► Associative rings and algebras

1078-16-69 **Martin Lorenz*** (lorenz@temple.edu). *Torus actions on affine PI-algebras.*

Let R be an algebra over an algebraically closed field k and let G be an affine algebraic k -group that acts rationally by k -algebra automorphisms on R . I will discuss the question as to when R has only finitely many G -prime ideals. The main focus will be on the case where R is an affine PI-algebra and G is an algebraic torus. (Received November 18, 2011)

1078-16-102 **Kulumani M Rangaswamy*** (ranga@uccs.edu), Department of Mathematics, University of Colorado at Colorado Springs, 1420 Austin Bluffs Parkway, Colorado Springs, CO 80918. *The theory of prime ideals of Leavitt path algebras over arbitrary graphs.*

Let E be an arbitrary directed graph and let K be any field. This talk will give an account of the recent investigation of the prime and primitive ideals of the Leavitt path algebra L of the graph E over the field K . Among the topics covered are Leavitt path algebras of specific Krull dimension, Height one prime ideals of L and their relation to the graphical properties of E . (Received November 27, 2011)

1078-16-168 **Gene Abrams*** (abrams@math.uccs.edu), Department of Mathematics, University of Colorado, 1420 Austin Bluffs Parkway, Colorado Springs, CO 80918, and **Zachary Mesyan** (zmesyan@uccs.edu). *Simple Lie algebras arising from Leavitt path algebras.* Preliminary report.

For a field K and directed graph E , we analyze those elements of the Leavitt path algebra $L_K(E)$ which lie in the commutator subspace $[L_K(E), L_K(E)]$. This analysis allows us to give easily computable necessary and sufficient conditions to determine which Lie algebras of the form $[L_K(E), L_K(E)]$ are simple, when E is row-finite and $L_K(E)$ is simple. (Received December 05, 2011)

1078-16-174 **Izuru Mori*** (simouri@ipc.shizuoka.ac.jp). *McKay Type correspondence for AS-regular algebras.*

One of the formulation of the classical McKay correspondence claims that the minimal resolution of the affine scheme associated to the fixed subalgebra of the polynomial algebra in two variables by a finite subgroup of the special linear group of degree 2 is derived equivalent to the preprojective algebra of the McKay quiver of that group. In this talk, we will see that there is a similar correspondence in the case that a finite cyclic subgroup of the general linear group of degree n acts on an AS-regular algebra in n variables. Since AS-regular algebras are noncommutative analogues of the polynomial algebra, this can be thought of as a McKay type correspondence in noncommutative algebraic geometry. (Received December 05, 2011)

1078-16-176 **Quanshui Wu*** (qswu@fudan.edu.cn), School of Mathematical Sciences, Shanghai, 200433, Peoples Rep of China. *Twisted Calabi-Yau Algebras and AS-regular (Hopf) Algebras.*

Some AS regular graded algebras and AS regular Hopf algebras can be constructed as iterated Ore extensions of lower dimensional algebras. We will prove that iterated Ore extensions preserve the twisted Calabi-Yau property or AS-regularity and describe the relation between the Nakayama automorphisms explicitly. (Received December 06, 2011)

1078-16-212 **Alexander A Young*** (aayoung@math.ucsd.edu), Department of Mathematics, 9500 Gilman Drive #0112, La Jolla, CA 92093-0112. *The growths of algebras: Examinations of several outstanding problems.*

The *growth* is an important invariant of a finitely generated group or affine algebra, and has been the subject of renewed interest. This talk will explore two questions in particular: what types of growth are possible for a nil algebra, and what types are possible for algebras that are Jacobson radical? There are three distinct general categories of group and algebra growth: polynomial, intermediate, and exponential. For algebras, the first category can be stratified by their Gelfand-Kirillov dimension, a non-negative number. Golod and Shafarevich were the first to prove the existence of nil affine algebras that are not finite-dimensional. Later, T. H. Lenagan and Agata Smoktunowicz and the presenter put forth a paper proving the existence of such algebras with any GK-dimension ≥ 3 , provided the base field is countable. In another paper, Jason Bell and the presenter proved that for any uncountable field, and any intermediate growth function, there exists an affine, nil, infinite dimensional algebra with growth bounded above by this function. In another paper put forward, Agata Smoktunowicz and

the presenter proved the existence of Jacobson Radical algebras that have quadratic growth, which is the smallest possible non-linear growth category. (Received December 08, 2011)

1078-16-213 **Chelsea Walton***, Department of Mathematics, Box 354350, Seattle, WA 98195-4350.
Representation theory of three-dimensional Sklyanin algebras.

We determine the dimensions of irreducible representations of the three-dimensional Sklyanin algebras. This contributes to the study of marginal deformations of the N=4 super Yang-Mills theory in four dimensions in supersymmetric string theory. Namely the classification of such representations is equivalent to determining the vacua of the aforementioned deformed theories. However the title and material of this talk are subject to change. (Received December 08, 2011)

1078-16-229 **Ellen E. Kirkman*** (kirkman@wfu.edu), Box 7388, Wake Forest University, Winston-Salem, NC 27109, and **James J. Kuzmanovich** and **James J. Zhang**.
Invariant subrings of $\mathbb{C}_{-1}[x_1, \dots, x_n]$ under permutation actions. Preliminary report.

Let $A = \mathbb{C}_{-1}[x_1, \dots, x_n]$ be the skew polynomial algebra $x_j x_i = -x_i x_j$ for all $i \neq j$. The symmetric group S_n acts on A by permuting the indices. Let G be a subgroup of S_n . The subring of invariants A^G is an Artin-Schelter Gorenstein algebra. We compare properties of A^G to those of invariants of the commutative polynomial ring $\mathbb{C}[x_1, \dots, x_n]^G$. (Received December 09, 2011)

1078-16-235 **Manizheh Nafari** (manizheh@uta.edu), **Michaela Vancliff*** (vancliff@uta.edu) and **Jun Zhang** (zhangjun19@gmail.com). *Classifying quadratic quantum planes using graded skew Clifford algebras.*

Graded skew Clifford algebras (GSCAs) are quantized analogs of graded Clifford algebras (GCAs) and were defined by the speaker and T. Cassidy. Like a GCA, many algebraic and homological properties of a GSCA may be read off from a certain system of (noncommutative) quadrics associated to the GSCA. This talk will focus on work of the speaker with M. Nafari and J. Zhang that proves that most quadratic quantum planes can be classified using GSCAs. (Received December 09, 2011)

1078-16-240 **Zak Mesyan***, Department of Mathematics, University of Colorado, Colorado Springs, CO 80918. *Commutator rings and Leavitt path algebras.*

An associative ring R is said to be a *commutator ring* if $R = [R, R]$, where $[R, R]$ is the subgroup of R generated by its additive commutators. There has been interest in such rings since at least 1956, when Kaplansky asked whether there could be a commutator division ring. To date, few examples of rings with this property have been produced, but it turns out that many such examples can be built using Leavitt path algebras. Commutator Leavitt path algebras have the additional unusual property that all their Lie ideals are (ring-theoretic) ideals. It is also possible to completely classify the commutator Leavitt path algebras, and in the process to describe the commutator subspace $[L_K(E), L_K(E)]$ of the Leavitt path algebra $L_K(E)$, for any field K and directed graph E . (Received December 10, 2011)

1078-16-244 **Milen Yakimov*** (yakimov@math.lsu.edu), Department of Mathematics, Louisiana State University, Baton Rouge, LA 70803. *Multiparameter quantum groups and quantum Schubert cells.*

Multiparameter twists of quantum groups and quantum Schubert cell algebras were considered by many authors after the work of Artin, Shelter and Tate. We will prove a conjecture of Brown and Goodearl that the prime ideals of the first class of algebras are completely prime. For the second class of algebras we will prove a conjecture of Goodearl and Lenagan that their H-primes are polynormal, compute the dimensions of the Goodearl-Letzter strata of their spectra, and prove that they are catenary. (Received December 10, 2011)

1078-16-302 **Christopher Ryan Nowlin***, cnowlin@math.ucsb.edu. *Torus-invariant prime spectra of Cauchon-Goodearl-Letzter extensions.* Preliminary report.

Fix a field k and q a generic scalar in k . Cauchon-Goodearl-Letzter (CGL) extensions are iteratively constructed skew polynomial algebras subject to hypotheses which allow Cauchon's theory of derivation-deleting homomorphisms to apply, as well as the stratification theory of Goodearl and Letzter. For the latter, we consider a CGL extension A and a suitably chosen algebraic torus acting rationally on A by automorphisms; the set of prime ideals of A invariant under the induced action of H forms a finite partially ordered set. In the case where A is a De Concini-Kac-Procesi algebra corresponding to an element w of a Weyl group W , an important theorem of Yakimov's guarantees that the torus-invariant prime spectrum of A will be isomorphic as a poset to the Bruhat order interval $[1, w]$ in W .

We will examine an iterative procedure for constructing isomorphisms between Bruhat order intervals and torus-invariant prime spectra, and see applications to understanding the prime spectra of CGL extensions not realizable as De Concini-Kac-Procesi algebras. (Received December 12, 2011)

1078-16-381 **Karel Casteels*** (casteels@math.ucsb.edu). *Primitive ideals in quantum matrices.*

I will discuss a combinatorial method for calculating generating sets of primitive ideals in the algebra of $m \times n$ quantum matrices. (Received December 13, 2011)

1078-16-386 **D. Rogalski*** (drogalsk@math.ucsd.edu), **S. J. Sierra** and **J. T. Stafford**. *Algebras in which every subalgebra is noetherian.*

We discuss examples of noncommutative algebras over a field with the intriguing property that all of their subalgebras are noetherian. The main such example we discuss is the coordinate ring of the affine surface obtained by removing the elliptic curve from the Sklyanin projective plane. In particular, such an example need not have GK-dimension 1, as in the commutative case. We also discuss some related open questions. (Received December 13, 2011)

1078-16-391 **S. Dascalescu**, **M C Iovanov*** (yovanov@gmail.com) and **C Nastasescu**. *Path algebras, path coalgebras and quantum groups constructed from quivers.*

There are two algebraic objects associated to any quiver Q : the quiver algebra $K[Q]$, and the quiver coalgebra KQ . A natural question is: what are the connections between the two, and what kind of bialgebra structures can be found on a quiver (co)algebra. We show that the path coalgebra can be obtained from the quiver algebra as a certain type of graded finite dual; also, it is the classical finite dual of the quiver algebra (i.e. the coalgebra of representative functions) if and only if the quiver is acyclic and only finitely many arrows exist between any two vertices. We also give some results about recovering the quiver algebra from the path coalgebra and a few similar results for incidence (co)algebras of partially ordered sets, and some applications. Finally, we present a few results regarding Hopf algebra structures on quivers, and on monomial algebras or coalgebras (i.e. coalgebras which embed in quiver coalgebras and which have a basis of paths). We classify such Hopf algebras which are monomial, and which are compact in a certain sense (i.e. which generalize algebras of representative functions on compact groups). These give rise to new classes of quantum groups, including, in particular, certain objects important in homological algebra and representation theory. (Received December 13, 2011)

1078-16-397 **Kenneth H Chan*** (kenhchan@math.washington.edu), University of Washington, Department of Mathematics, Box 354350, Seattle, WA 98195-4350. *Singularities arising as Hopf algebra actions.* Preliminary report.

We study invariant rings arising from finite dimensional Hopf algebras acting on AS-regular k -algebras. One of our goals is to investigate the analogue of the McKay correspondence in this context. We concentrate on the case of finite dimensional Hopf algebras acting "inner faithfully" on AS-regular k -algebras of global dimension 2. In this talk, we will present some examples and make some tentative conjectures.

This is joint work with E. Kirkman, C. Walton, and J. Zhang. (Received December 13, 2011)

17 ► *Nonassociative rings and algebras*

1078-17-89 **Young Jo Kwak*** (kwaky@colorado.edu), 491 Geneva St. D114, Aurora, CO 80010. *Automorphisms of simple Lie algebras $G(n)$ over $GF(2)$.*

Kaplansky introduced infinite family of simple Lie algebras $G(n)$ over $GF(2)$ in 1982, and Lin described $G(n)$ as the grading form. We define the combinatorial basis of $G(n)$, then $\text{Aut}((G(4)))$ is computed and $\text{Aut}(G(n)) = (Z/2Z) \times S_n$ for all $n > 4$ by the combinatorial basis. (Received November 23, 2011)

1078-17-131 **Kenyon J Platt*** (kenyon.platt@snow.edu). *Classifying the semisimple infinitesimal blocks of the parabolic category \mathcal{O} .*

Using a standard parabolic subalgebra \mathfrak{p}_S of a finite-dimensional semisimple Lie algebra \mathfrak{g} over the complex numbers, we can define a category of \mathfrak{g} -modules with certain nice 'finiteness' properties. This category, called a parabolic category, is a generalization of the Bernstein-Gelfand-Gelfand category \mathcal{O} . The parabolic category \mathcal{O}_S decomposes into special subcategories called infinitesimal blocks. Each infinitesimal block contains at most finitely many simple \mathfrak{g} -modules. We call an infinitesimal block consisting only of modules that are a direct sum of the simple modules in the block a semisimple block. In this talk, I will discuss a partial classification of the semisimple infinitesimal blocks and present a conjectured complete classification. (Received December 01, 2011)

18 ► *Category theory; homological algebra*

1078-18-84 **Adam Nyman*** (adam.nyman@wwu.edu). *A structure theorem for \mathbb{P}^1 – Spec k -bimodules.* Let k be an algebraically closed field. Using the Eilenberg-Watts theorem over schemes, we determine the structure of k -linear right exact direct limit and coherence preserving functors from the category of quasi-coherent sheaves on \mathbb{P}_k^1 to the category of vector spaces over k . As a consequence, we characterize those functors which are integral transforms. (Received November 22, 2011)

19 ► *K-theory*

1078-19-202 **Heath Emerson*** (hemerson@uvic.ca), Mathematics and Statistics, University of Victoria, PO Box 3060 STN CSC, Victoria, BC V8W 3R4, Canada, and **Bogdan Nica**. *Dirac classes for crossed-products.* Preliminary report.

We start by discussing when the crossed-product C^* -algebra associated to a discrete group acting smoothly on a compact manifold should be considered a noncommutative homology manifold. The condition we suggest is the existence of a certain fundamental K-homology class, which we call the ‘Dirac class’. We define Dirac classes, discuss their existence and uniqueness in general, and give several examples. If time permits, we describe a beautiful and simple representative of the Dirac class for a classical hyperbolic group acting on the boundary sphere of hyperbolic space, which uses only ergodic-theoretic considerations of the action (and not differential topology). (Received December 07, 2011)

1078-19-296 **Guoliang Yu*** (guoliang.yu@vanderbilt.edu), Department of Mathematics, Vanderbilt University, 1326 Stevenson Center, Nashville, TN 37240. *Algebraic K-theory of group algebras.* Preliminary report.

In this talk, I will discuss the computation of algebraic K-theory for group algebras and its applications to topology of manifolds and higher index theory of elliptic operators. This talk is partly based on joint work with Rufus Willett. (Received December 12, 2011)

20 ► *Group theory and generalizations*

1078-20-3 **Pham H. Tiep*** (tiep@math.arizona.edu), Department of Mathematics, University of Arizona, 617 N. Santa Rita Ave., Tucson, AZ 85721-0089. *Representations of finite groups: Conjectures, reductions, and applications.* Preliminary report.

We will discuss some basic problems in representation theory of finite groups, including some long-standing conjectures of Alperin, Brauer, and others. A possible approach to some of these problems is to use the classification of finite simple groups to reduce the problem in consideration to some, more specific, questions about simple groups. We will describe recent progress on reduction theorems in this direction. We will also outline applications of these results to various problems in group theory and algebraic geometry. (Received December 01, 2011)

1078-20-10 **Mark Sapir*** (m.sapir@vanderbilt.edu), SC 1326, Department of Mathematics, Vanderbilt University, Nashville, TN 37240. *The dimension growth of groups.*

This is a joint work with A. Dranishnikov. We show that the dimension growth of the R.Thompson group F is exponential while the dimension growth of some amenable subgroups of F is at least $\exp \sqrt{n}$. (Received September 05, 2011)

1078-20-13 **Yulan Qing*** (yulan.qing@tufts.edu), Bromfield-Pearson Hall, 503 Boston Ave., Medford, MA 02155. *Boundary of a CAT(0) 2-Complex.* Preliminary report.

We study the visual boundary of the universal cover of a torus complex proposed by Croke and Kleiner. Croke and Kleiner showed changing the intersecting angles of the gluing loops in the tori changes the homeomorphism type of the the boundary. This paper shows that if we change the length data of the gluing loops in the tori, the G-equivariant homomorphism does not extend to a homeomorphism on the boundary. However, we show that the two boundaries are indeed homeomorphic via another non group-induced homeomorphism. (Received September 19, 2011)

1078-20-26 **Gary M. Seitz*** (seitz@uoregon.edu). *Unipotent centralizers in algebraic groups.*

Let G be a simple algebraic group over an algebraically closed field of arbitrary characteristic and let u be a unipotent element of G . We will discuss the problem of determining whether or not u is contained in the connected component of its centralizer in G ? If the characteristic of the underlying field is "good," then this always holds. However, in "bad characteristic" the answer is subtle and quite interesting. (Received October 20, 2011)

1078-20-28 **Mark L. Lewis*** (lewis@math.kent.edu), Department of Mathematical Sciences, Kent State University, Kent, OH 44242, and **Qingyun Meng**. *Square character degree graphs yield direct products.*

If G is a solvable group, we take $\Delta(G)$ to be the character degree graph for G with primes as vertices. We prove that if $\Delta(G)$ is a square, then G must be a direct product. (Received October 31, 2011)

1078-20-29 **Jason E Fulman*** (fulman@usc.edu). *Random walk on irreducible representations of finite groups.*

We study random walks on the set of irreducible representations of a finite group. These are naturally dual to random walks on finite groups, but do not seem to have been systematically studied. In this talk we give some convergence rates results for the symmetric and general linear groups, and indicate the usefulness of these random walks for Stein's method. (Received October 31, 2011)

1078-20-31 **Kay Magaard*** (k.magaard@bham.ac.uk), School of Mathematics, University of Birmingham, Birmingham, B15 2TT, England, **Gerhard Roehle** (gerhard.roehle@rub.de), Fakultät für Mathematik, Universitätsstrasse 150, D-44780 Bochum, Germany, and **Donna Testerman** (donna.testerman@epfl.ch), Section de Mathématiques, EPFL, Station 8, CH-1015 Lausanne, Switzerland. *Tensor products of cross characteristic representations of classical groups.*

Let H be a quasisimple group of Lie type of characteristic p , and W a vector space over an algebraically closed field k of characteristic distinct from p . Suppose that H acts irreducibly on W and that G is a classical group with natural module W . Suppose also that G is chosen minimally with respect to containing H . We consider the question of when H can act irreducibly on a G constituents of $W^{\otimes e}$ and its relationship to the maximal subgroup problem to finite classical groups. (Received November 01, 2011)

1078-20-33 **Persi Diaconis***, Department of Statistics, Stanford University, Stanford, CA 94305. *When least is best.* Preliminary report.

In studying mixing times of random walk on groups, the following problem arises: Let G be a finite group and S a symmetric generating set. A random walk starts out at the identity and each time moves by translating by a randomly chosen element of S . After k steps, which element is least likely? For some G and S the computer shows that the answer is something like "the element farthest from the identity" (some conditions apply). Sometimes this can be proved (eg. for cyclic groups) but even for the generating set of transpositions on the symmetric group it has defeated us. This least likely element determines mixing time estimates. The parallel question for most likely is easy (for even k the walk is most likely to be back at the identity). All of this is from an ongoing conversation with Marty Isaacs. (Received November 02, 2011)

1078-20-36 **Amanda A. Schaeffer Fry*** (mandi@math.arizona.edu). *Cross-characteristic representations of $Sp_6(q)$, q even, and their restrictions to maximal subgroups.*

We describe the p -modular irreducible representations of $G = Sp_6(q)$, q even, for any $p \neq 2$. Then we classify all pairs (V, H) where H is a maximal subgroup of G and V is a p -modular representation of G which is absolutely irreducible as a representation of H . This problem is motivated by the Aschbacher-Scott program on classifying maximal subgroups of finite classical groups. (Received November 03, 2011)

1078-20-91 **Bhama Srinivasan*** (srinivas@uic.edu), Department of Mathematics, m/c 249, University of Illinois at Chicago, 851 S.Morgan St, Chicago, IL 60607. *Graded representations of $GL(n, q)$.* Preliminary report.

J.Brundan and A.Kleshchev [Advances in Math. 222 (2009), 1883-1942] showed that cyclotomic Hecke algebras can be graded, and introduced graded decomposition numbers for these algebras. Using their results, Ariki showed that q -Schur algebras can be graded and one can also consider graded decomposition numbers in that case. We prove similar results for $GL(n, q)$, including a graded analog of a result of Dipper-James which connects a part of the ℓ -modular decomposition matrix of $GL(n, q)$ (where ℓ is prime to q) with the decomposition matrix of the q -Schur algebra. (Received November 23, 2011)

1078-20-99 **Jason Behrstock*** (jason.behrstock@lehman.cuny.edu) and **Cornelia Drutu**.
Divergence, thick groups, and morse geodesics.

In a metric space the divergence of a pair of rays is a way to measure how quickly they separate from each other. Understanding what divergence rates are possible in the presence of non-positive curvature was raised as a question by Gromov and then refined by Gersten. We will describe a construction of groups with several interesting properties, including shedding light on the above question. (Received November 26, 2011)

1078-20-100 **Alexei Miasnikov*** (amiasnikov@gmail.com), Department of Math., Stevens Institute, Hoboken, NJ 07030. *Algorithmic problems in metabelian groups.*

I will discuss recent results on geometric and algorithmic properties of metabelian groups. (Received November 27, 2011)

1078-20-101 **Alexander Yu. Olshanskiy*** (alexander.olshanskiy@vanderbilt.edu), 1326 Stevenson Center, Department of Mathematics, Vanderbilt University, Nashville, TN 37240.
Derivation space and computation space in semigroups and groups.

We introduce the space function $s(n)$ of a finitely presented semigroup $S = \langle A \mid R \rangle$. To define $s(n)$ we consider pairs of words w, w' over A of length at most n equal in S and use relations from R for the derivations $w = w_0 \rightarrow \dots \rightarrow w_t = w'$; $s(n)$ bounds from above the lengths of the words w_i -s at intermediate steps, i.e., the space sufficient to implement all such transitions $w \rightarrow \dots \rightarrow w'$. One of the results obtained is the following criterion: A finitely generated semigroup S has decidable word problem of polynomial space complexity if and only if S is a subsemigroup of a finitely presented semigroup H with polynomial space function. Similar results for groups were obtained by the author earlier although in the group case, an extended set of transformations was used in the definition of derivation. (Received November 27, 2011)

1078-20-107 **I. M. Isaacs*** (isaacs@math.wisc.edu), Math. Dept., University of Wisconsin, 480 Lincoln Dr., Madison, WI 53706, and **Gabriel Navarro** (gabriel@uv.es). *Groups whose real irreducible characters have degrees coprime to p .*

A well-known theorem of N. Ito asserts that if G is solvable and no irreducible character of G has degree divisible by a given prime p , then G has a normal abelian Sylow p -subgroup. (The solvability requirement was later removed by G. Michler, using the simple group classification.) In this paper, we consider what happens if only the real-valued irreducible characters of G are assumed to have degrees coprime to p , where $p > 2$.

Tiep showed that in this situation, G must have a solvable normal subgroup with p' -index. We take Tiep's conclusion as a starting point, and we prove that G has a normal subgroup K of odd index such that K has a normal Sylow p -subgroup. We show, furthermore, that every real element of G normalizes some Sylow p -subgroup of G . (Received November 28, 2011)

1078-20-116 **Michael Aschbacher***, Caltech, Pasadena, CA 91125. *Tightly embedded subsystems of fusion systems.*

Tightly embedded subsystems of fusion systems

Let G be a finite group. A *tightly embedded subgroup* of G is a subgroup K of even order such that $K \cap J$ is of odd order for each conjugate J of K distinct from K . Tightly embedded subgroups play an important role in the classification of the finite simple groups. We define a notion of a *tightly embedded subsystem* of a fusion system, and prove analogues, for 2-fusion systems, of theorems on tightly embedded subgroups. These results are part of a program to simplify portions of the classification of the finite simple groups using the theory of fusion systems. (Received November 29, 2011)

1078-20-119 **M I Elashiry** and **D S Passman*** (passman@math.wisc.edu), Department of Mathematics, 603 Van Vleck Hall, University of Wisconsin, Madison, WI 53706. *Rewritable groups.*

A group G is said to satisfy the n -permutational property P_n if for all n -tuples (g_1, g_2, \dots, g_n) of group elements, there exists a nonidentity permutation $\sigma \in \text{Sym}_n$ (depending upon the n -tuple) with $g_1 g_2 \dots g_n = g_{\sigma(1)} g_{\sigma(2)} \dots g_{\sigma(n)}$. Similarly, G satisfies the n -rewritable property Q_n if for all n -tuples (g_1, g_2, \dots, g_n) , there exist distinct permutations $\sigma, \tau \in \text{Sym}_n$ with $g_{\sigma(1)} g_{\sigma(2)} \dots g_{\sigma(n)} = g_{\tau(1)} g_{\tau(2)} \dots g_{\tau(n)}$. Obviously, P_n implies Q_n , but it is known that the converse is not true. Here we prove a conjecture of Blyth that Q_n implies P_m , where m is a fixed function of n . For this, we first show that there exist finite-valued functions $a(n)$ and $b(n)$ so that if G satisfies Q_n , then G has a characteristic subgroup N such that $|G : N| \leq a(n)$ and $|N'| \leq b(n)$. The conjecture then follows with $m = a(n)(b(n) + 1)$. (Received November 29, 2011)

1078-20-137 **Timothy C. Burness, Soumaia Ghandour, Claude Marion and Donna M. Testerman*** (donna.testerman@epfl.ch), EPFL-FSB-MATHGEOM, Station 8, 1015 Lausanne, Switzerland. *Irreducibly acting subgroups of classical algebraic groups*. Preliminary report.

The problem we consider is the classification of proper closed positive-dimensional subgroups of classical algebraic groups (defined over an algebraically closed field) which act irreducibly on some rational representation space for the classical group. This complements work of Seitz who considered connected subgroups and Ford who considered certain disconnected subgroups. We have obtained a complete classification for positive-dimensional maximal subgroups. (Received December 02, 2011)

1078-20-152 **Hung Ngoc Nguyen*** (hungnguyen@uakron.edu), The University of Akron, Department of Mathematics, Akron, OH 44325, and **Hung P. Tong-Viet** and **Thomas P. Wakefield**. *Characterizing quasi-simple groups by the degrees of their irreducible representations*.

Let $\text{cd}(G)$ and $\text{cd}^*(G)$ denote the set and multiset, respectively, of the degrees of irreducible representations of a finite group G . We present some recent progress on a conjecture of Huppert that if H is a quasi-simple group and $\text{cd}(G) = \text{cd}(H)$, then G and H are isomorphic up to an abelian direct factor. We also discuss some results on a weaker conjecture that if H is a quasi-simple group and $\text{cd}^*(G) = \text{cd}^*(H)$, then G and H are isomorphic. (Received December 04, 2011)

1078-20-157 **David Hume*** (hume@maths.ox.ac.uk). *Direct embeddings of relatively hyperbolic groups with optimal ℓ^p compression exponent*.

We present direct methods for embedding hyperbolic and tree-graded simplicial graphs with bounded geometry into ℓ^p spaces and describe how such constructions can be adapted to the case of asymptotically tree-graded simplicial graphs with bounded geometry. (Received December 05, 2011)

1078-20-158 **Sean Cleary*** (cleary@sci.cuny.cuny.edu), Department of Mathematics, The City College of New York, Convent Ave at 138th St, New York, NY. *Density of subgroups of Thompson's group F* .

There are a number of possible notions of constructing k -generator subgroups "at random" from a fixed group G . Given such a process, we can try to understand properties that a random subgroup has. In earlier work with Murray Elder, Andrew Rechnitzer and Jennifer Taback, we estimated densities of particular isomorphism classes of subgroups with respect to a method of selecting subgroups based upon selecting tree pair diagrams at random. Here, in work with Andrew Rechnitzer and Thomas Wong, we investigate the density of such subgroups which lie in abelian products inside Thompson's group F . (Received December 05, 2011)

1078-20-169 **Matthew B. Day***, 301 SCEN, Department of Mathematics, University of Arkansas, Fayetteville, AR 72701, and **Andrew Putman**. *Relations in the Torelli subgroup of $\text{Aut}(F_n)$* . Preliminary report.

The Torelli subgroup of $\text{Aut}(F_n)$ is the set of elements acting trivially on the abelianization of F_n . We study the intersection of the Torelli subgroup with the stabilizer in $\text{Aut}(F_n)$ of the conjugacy class of a primitive element in F_n . Using our earlier work on a Birman exact sequence for $\text{Aut}(F_n)$, we can produce interesting infinite presentations for this intersection. This is part of a program to produce an infinite presentation for the Torelli subgroup itself. (Received December 05, 2011)

1078-20-180 **Jon F Carlson*** (jfc@math.uga.edu), Department of Mathematics, University of Georgia, Athens, GA 30602. *News on endotrivial modules*. Preliminary report.

We will discuss recent developments in the effort to classify endotrivial modules and endopermutation modules over general finite groups. Some concentration will be on some open problems that are the current sticking points including relations to block theory. (Received December 06, 2011)

1078-20-186 **Tara C Davis*** (tdavis@hpu.edu), 1164 Bishop Street, UB210A, Honolulu, HI 96813, and **Alexander Yu. Olshanskii** (alexander.olshanskiy@vanderbilt.edu), 1326 Stevenson Center, Vanderbilt University, Nashville, TN 37240. *Subgroup Distortion in Wreath Products of Cyclic Groups*.

I will discuss some effects of subgroup distortion in the wreath products $A \text{ wr } \mathbb{Z}$, where A is finitely generated abelian. The effects of distortion in these groups is similar to that in free metabelian groups. One result is that every finitely generated subgroup of $A \text{ wr } \mathbb{Z}$ has distortion function equivalent to some polynomial. I will also mention a formula for the length of elements in arbitrary wreath product $H \text{ wr } G$, and how it applies to distortion. (Received December 06, 2011)

1078-20-188 **Aaron Abrams** and **Praphat Xavier Fernandes*** (pxferna@emory.edu), Dept. of Math and CS, Emory University, 400 Dowman Dr., W401, Atlanta, GA 30322. *Quasi-Isometric Properties of Graph Braid Groups.*

We introduce a quasi-isometric invariant for graph braid groups. As an application we will use it to show that the graph braid groups $B_2(K_n)$ are quasi-isometrically distinct for all n . We will then discuss some properties of the invariant as well as possible generalizations. (Received December 06, 2011)

1078-20-199 **Bhama Srinivasan** (srinivas@uic.edu), Dept. of Mathematics, Comp. Sci., and Stat., University of Illinois at Chicago, 851 South Morgan Stree, Chicago, IL 60680-7045, and **C. Ryan Vinroot*** (vinroot@math.wm.edu), Department of Mathematics, College of William and Mary, P. O. Box 8795, Williamsburg, VA 23187-8795. *Semisimple symplectic characters of finite unitary groups.*

Let $G = U(2m, \mathbb{F}_{q^2})$ be the finite unitary group defined over a finite field of order q , where q is the power of an odd prime p . We prove that the number of irreducible complex characters of G with degree coprime to p , and with Frobenius-Schur indicator -1 , is equal to q^{m-1} . In particular, we find a (non-canonical) bijection between these irreducible characters and the set of self-dual polynomials of degree $2m$ over \mathbb{F}_q with constant term -1 . (Received December 07, 2011)

1078-20-285 **John Shareshian*** (shareshi@math.wustl.edu) and **Russ Woodroffe**. *Nontrivial homology of coset posets of finite groups.*

Let G be a finite group. The coset poset $CP(G)$ is the set of all cosets of all proper subgroups of G , partially ordered by inclusion. The order complex $\Delta CP(G)$ is the abstract simplicial complex whose faces are totally ordered subsets of $CP(G)$. K. S. Brown asked whether the geometric realization of $\Delta CP(G)$ can be contractible. We have shown that if $\Delta CP(G)$ has trivial reduced homology then some composition factor of G is an alternating group of degree greater than 5,000,000. Efforts to handle arbitrary alternating composition factors using our method lead to a number theoretic problem that seems to be of independent interest. Using a different method, we have shown that if G is an alternating or symmetric group then $\Delta CP(G)$ has nontrivial reduced homology. (Received December 12, 2011)

1078-20-295 **Joel Louwsma*** (jlouwsma@ou.edu), Department of Mathematics, The University of Oklahoma, Norman, OK 73019-3103. *Extremality of the rotation quasimorphism on the modular group.*

It follows from work of Bavard that $\text{scl}(A) \geq \text{rot}(A)/2$ for any element A of the modular group $\text{PSL}(2, \mathbb{Z})$, where scl denotes *stable commutator length* and rot denotes the *rotation quasimorphism*. Sometimes this bound is sharp, and sometimes it is not. We study which elements $A \in \text{PSL}(2, \mathbb{Z})$ have the property that $\text{scl}(A) = \text{rot}(A)/2$. First we describe some experimental results based on computation of stable commutator length. Then we discuss the following stability theorem: for any element of the modular group, the product of this element with a sufficiently large power of a parabolic element is an element that satisfies $\text{scl} = \text{rot}/2$. This result is joint work with Danny Calegari. (Received December 12, 2011)

1078-20-315 **Olga Kharlampovich***, okharlampovich@gmail.com, and **Alexei Myasnikov**. *Definable subsets in a free group.*

We give a description of definable subsets in a free non-abelian group F that follows from our work on the Tarski problems. As a corollary we show that proper non-abelian subgroups of F are not definable (Malcev's problem) and prove Bestvina and Feighn's result that definable subsets in a free group are either negligible or co-negligible. (Received December 12, 2011)

1078-20-330 **Michael Hull*** (michael.b.hull@vanderbilt.edu), Department of Mathematics, Vanderbilt University, Nashville, TN 37240. *Quasimorphisms and bounded cohomology of groups with hyperbolically embedded subgroups.*

Quasimorphisms have been used by Brooks, Bestvina, Fujiwara, and others to show the infinite dimensionality of the second bounded cohomology of many groups acting on hyperbolic spaces. Building on their methods, we will show that if a subgroup H is hyperbolically embedded in G (which is a generalized version of relative hyperbolicity), then any quasimorphism of H can be extended to a quasimorphism of G which will, in most cases, induce a nontrivial element in $H_b^2(G, \mathbb{R})$. (Received December 12, 2011)

1078-20-357 **Noel Brady*** (nbrady@math.ou.edu), Department of Mathematics, 423 PHSC, 601 Elm Ave, Norman, OK 72019. *Modified right-angled Artin groups.*

We define modified right-angled Artin groups. As is the case with right-angled Artin groups, these groups can be encoded via a finite graph (with some edge decorations), they are CAT(0) cubical groups, they admit homomorphisms onto the infinite cyclic group, and the clique complex corresponding to the finite graph is reflected in the asymptotic topology of the kernels. We present some results about the asymptotic geometry and topology of the kernels. (Received December 13, 2011)

1078-20-361 **Jan Saxl*** (saxl@dpms.cam.ac.uk), DPMMS, CMS, Wilberforce Road, Cambridge, CB3 0WB, England. *On primitive Gelfand pairs.*

A Gelfand pair consists of a group G and a subgroup H with the permutation character multiplicity free. There are many interesting examples, including in particular examples involving each simple group G . In this talk we shall survey recent progress towards the classification of primitive Gelfand pairs. This is largely joint work with John van Bon and Nick Inglis. (Received December 13, 2011)

1078-20-408 **Chris Hruska*** (chruska@uwm.edu) and **Daniel Wise**. *Cubulating relatively hyperbolic groups.*

Sageev showed how to construct a CAT(0) cube complex dual to a system of “walls” in a space. If a group acts on this “wallspace” then the group also acts on the dual CAT(0) cube complex. Many basic properties of this action are difficult to determine in practice. For instance, is the action cocompact? Is the cube complex even finite dimensional?

We are particularly interested in the special case of a group G that is hyperbolic relative to subgroups P_1, \dots, P_r . If G acts on a wallspace, then G acts relatively cocompactly on the associated dual CAT(0) cube complex. When the subgroups P_1, \dots, P_r are abelian, we show that the dual CAT(0) cube complex has a G -cocompact CAT(0) truncation.

Our main result plays a critical role in Wise’s recent work on groups with a quasiconvex hierarchy, where it is used to understand the dual cube complex arising for a cusped hyperbolic 3-manifold. (Received December 13, 2011)

22 ► Topological groups, Lie groups

1078-22-23 **Min Kyu Kim*** (mkkim@kias.re.kr), Department of Mathematics Education, Gyeongin National University of Education, San 59-12, Gyesan-dong, Gyeyang-gu, Incheon, 407-753, South Korea. *Equivariant vector bundles over 2-sphere.*

Equivariant topological complex vector bundles over 2-sphere under a compact Lie group (not necessarily effective) action are classified. We show that nonequivariant Chern classes and isotropy representations at (at most) 3 points are sufficient to classify isotypical components of equivariant vector bundles over 2-sphere. (Received October 18, 2011)

1078-22-110 **Kam-Fai Tam*** (geo.tam@utoronto.ca), Department of Mathematics, University of Toronto, Room 6290, 40 St. George Street, Toronto, Ontario M5S 2E4, Canada. *Admissible embedding of L-groups and essentially tame local Langlands correspondence.*

Let F be a non-Archimedean local field. Bushnell and Henniart described an explicit bijection between the essentially tame Langlands parameters, i.e. irreducible representations of the Weil group W_F of dimension n , and the essentially tame irreducible supercuspidal representations of $GL_n(F)$. This is known as the essentially tame local Langlands correspondence. We can regard each Langlands parameter as a representation twisted-induced from a character ξ of a tamely ramified subgroup W_E of W_F of degree n . Here a twist refers to another character μ_ξ of E^\times called the rectifier of ξ . We prove that the rectifier admits a factorization such that the factors are parameterized by the isotypic components of a finite symplectic module arising from the construction of the corresponding supercuspidal representation from ξ . With such factorization, we can express our Langlands parameter in terms of an admissible embedding of L-groups constructed by Langlands and Shelstad. Therefore we give a different interpretation of the essentially tame local Langlands correspondence.

Preprints are available at arXiv:1109.4529, 1111.4731 and 1111.4732. (Received November 28, 2011)

1078-22-165 **Isaac Martin Goldbring*** (isaac@math.ucla.edu), 520 Portola Plaza Box 95155, Los Angeles, CA 90095-1555. *Nonstandard hulls of locally uniform groups.* Preliminary report.

In this talk, we show how to adapt Luxembourg’s construction of the nonstandard hull of a uniform space to the special case of a topological group whose operations are uniformly continuous near the identity. In this case, the

nonstandard hull is naturally a local group. We will discuss such topics as how the nonstandard hull depends on the choice of defining pseudometrics, the relation with Pestov's nonstandard hull construction for Banach-Lie groups, and the connection with Enflo's theory of groups uniformly free from small subgroups. (Received December 05, 2011)

28 ► *Measure and integration*

1078-28-71 **luke rogers***, luke.rogers@uconn.edu. *Laplacian spectra on N-gasket fractals.*

I will explain a method for computing Laplacian spectra on N-gasket fractals that involves a much lower dimensional dynamical system than might usually be expected. This is based on joint work with Martin Kassabov. (Received November 18, 2011)

1078-28-104 **Jun Kigami*** (kigami@i.kyoto-u.ac.jp), Kyoto, Kyoto 606-8501, Japan. *Partition, volume doubling property and quasisymmetry on metric spaces.* Preliminary report.

In this talk, we will propose a legitimate definition of a partition of a compact metric space by a tree. Moreover, we give a notion of metrics which is adapted to given partition of the space. Under given adapted metric to a partition, an equivalent condition of a measure begin volume doubling with respect to an adapted metric and an equivalent condition for another metric being quasisymmetric with respect to the given metric are studied. One of examples where this scheme can be applied is the self-similar sets. (Received November 28, 2011)

1078-28-148 **Karel Hrbacek*** (khrbacek@sci.cuny.cuny.edu). *A nonstandard approach to length and area.* Preliminary report.

In 1975, P. Loeb famously gave a nonstandard construction of the Lebesgue measure in \mathbb{R}^n . I consider a generalization of this construction to k -dimensional, translation and rotation invariant (outer) measures in \mathbb{R}^n , for $k \leq n$. The procedure requires (at least) two "levels of standardness." (Received December 04, 2011)

1078-28-335 **Rolando De Santiago, Michel L Lapidus, Scott Roby*** (sroby001@ucr.edu) and **John A Rock.** *Lattice self-similar strings and self-similar multifractals.*

A self-similar measure is lattice in regularity α if the fractal string associated with the coarse Holder regularity α is lattice in the sense of classic fractal strings. The multifractal spectrum stemming from the abscissa of convergence function of the measure with regard to its partition zeta functions can be extended, in the cases of the values of α for which the measure is lattice, to a partial tapestry of complex dimensions. Employing the theory of complex dimensions of fractal strings allows one to determine counting functions associated with these regularity values and the corresponding partition zeta functions. (Received December 12, 2011)

1078-28-336 **Rolando De Santiago, Michel L Lapidus, Scott Roby and John A Rock*** (jarock@csupomona.edu). *Discrete generalized fractal strings and generalized lattice strings.*

In this talk, we discuss two related special cases of generalized fractal strings. The first case considers discrete generalized fractal strings which have weights given by a countably infinite nondecreasing sequence of positive real numbers which are not necessarily integer. In this setting, the geometric zeta function is shown to be equal to a Dirichlet series whose form is reminiscent of the geometric zeta function of an ordinary fractal string. The second case considers discrete generalized fractal strings whose weights are complex-valued and yet the scales are powers of a unique positive real number which is less than one. Hence, in this setting, we establish a generalization of lattice strings to include complex multiplicities which are determined via a corresponding recurrence relation. (Received December 12, 2011)

30 ► *Functions of a complex variable*

1078-30-198 **Alexander L Volberg*** (volberg@math.msu.edu), MSRI, 17 Gauss way, Berkeley, CA 94720. *Astala's conjecture and non-homogenous harmonic analysis.*

Astala proved the sharp Hausdorff dimension distortion results for quasiconformal mappings of the plane. He conjectured that the borderline result, namely, the result where the Hausdorff dimension is replaced by Hausdorff measure in sharp dimension also holds. This conjecture was proved not long ago by M. Lacey, E. Sawyer and I. Uriarte-Tuero. The proof is not easy and it hinges on a certain highly non-trivial weighted estimate of a Singular Operator. It will be shown in the talk how to imbed this estimate to the realm of non-homogenous Harmonic Analysis, make it an unweighted estimate in this new environment, and significantly simplify the proof as a result of this point of view. (Received December 07, 2011)

1078-30-200 **Mishko Mitkovski** (mishko@math.gatech.edu), School of Mathematics, Georgia Institute of Technology, 686 Cherry Street, Atlanta, GA 30332-1060, and **Brett D. Wick*** (wick@math.gatech.edu), School of Mathematics, Georgia Institute of Technology, 686 Cherry Street, Atlanta, GA 30308. *Uniqueness Sets in the Fock Space.*

The Bargmann-Fock space \mathcal{F} consists of all entire functions such that

$$\int_{\mathbb{C}} |F(z)|^2 e^{-\pi|z|^2} dA(z) < \infty.$$

In this talk we consider a class of sequences and show that they are uniqueness sequences in \mathcal{F} . (Received December 07, 2011)

1078-30-236 **Hasi Wulan*** (wulan@stu.edu.cn), Department of Mathematics, Shantou University, Shantou, Guangdong 515063, Peoples Rep of China. *A decomposition theorem for Qk spaces.*

In this talk I will give a decomposition theorem for Qk spaces of analytic functions. As an application of the decomposition theorem, a characterization of interpolation by functions in Qk spaces will be mentioned. (Received December 09, 2011)

1078-30-326 **Austin Anderson*** (austina@hawaii.edu), 3810 Leahi Ave #104, Honolulu, HI 96815. *A Volterra type operator on H^∞ .*

The operator T_g , with symbol g an analytic function on the disk D , is defined by $T_g f(z) = \int_0^z f(w)g'(w) dw$, $z \in D$. T_g appears in a few different settings in complex analysis, relating to the John-Nirenberg inequality, semi-groups of composition operators, and weak factorization of spaces of analytic functions. Characterizing operator theoretic properties, such as boundedness and compactness, of T_g on various spaces has attracted interest, and much is still unknown regarding this. A natural open question is to ask for a characterization of the symbols g for which T_g is bounded on H^∞ . We discuss possible answers to this question. (Received December 12, 2011)

1078-30-355 **Donald E Marshall*** (marshall@math.washington.edu), Department of Mathematics, University of Washington, PO Box 354350, Seattle, WA 98195-4350. *Geodesic zippers.*

We will discuss a simple and flexible algorithm for the numerical computation of conformal maps, demonstrating its application to various conformal welding problems. (Received December 13, 2011)

31 ► Potential theory

1078-31-47 **Hiroaki Aikawa*** (aik@math.sci.hokudai.ac.jp), Kita 10, Nishi 8, Sapporo, Hokkaido 060-0810, Japan. *Extended Harnack inequalities.*

The Harnack inequality is one of the most fundamental inequalities for positive harmonic functions and, more generally, for positive solutions to elliptic equations and parabolic equations (De Giorgi-Nash-Moser theory).

This talk gives a different view point of generalization. Namely, we generalize Harnack chains rather than equations. More precisely, we allow a *small exceptional set* in the Harnack chain and yet we obtain a similar Harnack inequality. In light of inextricable relationships between harmonic functions and Brownian motions, such a generalization is plausible. However, it is not so easy to give a rigorous formulation. We introduce a *Harnack double chain* in association with quasihyperbolic metric and measure the size of an exceptional set by capacity. We observe that an extended Harnack inequality gives a boundary Harnack principle for a very nasty domain. (Received November 10, 2011)

32 ► Several complex variables and analytic spaces

1078-32-64 **Mutsuo Oka*** (oka@rs.kagu.tus.ac.jp), Depart. of Math., Faculty of Sciences, Tokyo, Univ. Science, 1-3 Kagurazaka, Shinjuku-ku, Tokyo, 162-8601. *Mixed functions of strongly polar weighted homogeneous face type.* Preliminary report.

Let $f(\mathbf{z}, \bar{\mathbf{z}})$ be a mixed polynomial with strongly non-degenerate face functions. Then there exists a canonical resolution $\pi : X \rightarrow \mathbb{C}^n$ of the hypersurface germ (V, \mathbf{o}) with $V = f^{-1}(0)$ such that π is a composition of a canonical toric modification $\pi_\Sigma : X_\Sigma \rightarrow \mathbb{C}^n$ and a polar modification $\pi_{\mathbb{R}} : X \rightarrow X_\Sigma$ along the exceptional divisors of π_Σ . In this talk, we assume that each face function is strongly polar weighted homogeneous and we will show that the toric modification already resolves the singularity of V and we give a generalization of Varchenko Theorem on the zeta function of the Milnor fibration. (Received November 17, 2011)

1078-32-125 **Shuzo Izumi***, 415-5 Kohmyo, Ikoma, Nara 630-0201, Japan. *Higher order tangent spaces of an embedded complex manifold and Taylor projectors.*

Given a finite dimensional vector space Z of holomorphic functions on an open subset $U \subset \mathbb{C}^n$, we define a projector from the algebra $\mathcal{O}_{\mathbf{b}}$ of holomorphic functions at $\mathbf{b} \in U$ onto the space $Z_{\mathbf{b}} \subset \mathcal{O}_{\mathbf{b}}$ of germs of elements of Z at \mathbf{b} . First we prove that $Z_{\mathbf{b}}$ has a structure of factor algebra of $\mathcal{O}_{\mathbf{b}}$ at a general point \mathbf{b} . Using this projector, we define the Taylor expansion of order d for the functions on an embedded submanifold $X \subset \mathbb{C}^m$ at a general point. These generalise the results of Bos and Calvi on an plane algebraic curve. To show this, we need a special kind of higher order tangent space of X . The growth of this space with respect to the order measures local simplicity of the embedding. We obtain a zero-estimate formula for analytic functions. This implies that X is embedded in \mathbb{C}^m in not highly transcendental manner excepting points of a set of Lebesgue measure 0 in X .

(Received December 01, 2011)

1078-32-192 **HIROAKI TERAOKA** (hteraok00@za3.so-net.ne.jp), Department of Mathematics, Hokkaido University, Kita-10, Nishi-8, Kita-ku, Sapporo, Hokkaido 060-0810, Japan, and **DAISUKE SUYAMA*** (dsuyama@math.sci.hokudai.ac.jp), Department of Mathematics, Hokkaido University, Kita-10, Nishi-8, Kita-ku, Sapporo, Hokkaido 060-0810, Japan. *Primitive derivations, Shi arrangements and Bernoulli polynomials.* Preliminary report.

Let W be a finite irreducible real reflection group, which is a Coxeter group. A primitive derivation plays a crucial role in the theory of differential forms with logarithmic poles along the Coxeter arrangement. For example, we may describe the contact order filtration of the logarithmic derivation module using the primitive derivations. The contact order filtration is closely related to the Frobenius manifold structure of the orbit space. In particular, when W is a finite Weyl group, we have a one-parameter deformation of the contact order filtration by considering the extended Shi arrangements associated to the root systems. In there, the Bernoulli polynomials canonically appear in the expressions. (Received December 06, 2011)

1078-32-259 **kyesook Nam***, Department of Mathematical Sciences, Seoul National University, 1 Gwanak-ro, Gwanak-Gu, Seoul, 151-747, South Korea. *Characterizations of harmonic Bergman spaces.*

In this talk, we characterize the harmonic Bergman spaces by means of integrability conditions of double integrals associated with difference quotients of harmonic functions. The characterizations for the holomorphic case were divided into two parts caused by the critical case $p = n + \alpha + 1$ (here n is the complex dimension). We also give the characterization of the harmonic Bergman spaces for the critical case which is missing in the result for the holomorphic case.

The talk is based on a joint work with Prof. B.R.Choe. (Received December 11, 2011)

1078-32-267 **Camille Plénat** and **David J. A. Trotman*** (trotman@cmi.univ-mrs.fr), Centre de Mathématiques et Informatique, Aix-Marseille Université, 39 rue Joliot-Curie, 13453 Marseille Cedex 13, France. *On Teissier's 1972 conjecture concerning the equimultiplicity of families of complex hypersurface-germs with constant Milnor number.*

As a parametrised version of Zariski's (still unanswered) question about the topological invariance of the multiplicity of a complex hypersurface singularity, Teissier conjectured in 1972 that families of isolated complex hypersurface singularities with constant Milnor number are equimultiple. We show that any possible drop in multiplicity in a polynomial family $F(z, t)$ of complex analytic hypersurface singularities with constant Milnor number, parametrised by t , is controlled by the powers of t in that the coefficient of t^k must have a multiplicity greater than or equal to $m - k + 1$ where m is the multiplicity of $f(z) = F(z, 0)$. We prove equimultiplicity of μ constant families of the form $f + tg + t^2h$ if the singular set of the tangent cone of $f = 0$ is not contained in the tangent cone of $h = 0$. Generalising our proof of this provides further constraints on possible counterexamples to Teissier's conjecture. (Received December 11, 2011)

1078-32-333 **Terence Gaffney*** (t.gaffney@neu.edu), Department of Mathematics, Northeastern University, Boston, MA 02115. *Multiplicity of pairs of modules and singularities.*

Gaffney's work on equisingularity conditions provides a framework for describing the geometry of singularities in many settings. Here we discuss joint work with Nivaldo Grulha Jr. for calculating local contributions to Chern numbers of families of differential forms on singular spaces. If time permits, recent improvements to the framework, lessening dependence on the families of objects, will be described. (Received December 12, 2011)

33 ► *Special functions*

1078-33-19 **Ben T Nohara*** (drben@tcu.ac.jp), 1-28-1 Tamatsutsumi, Setagaya-ku, Tokyo, 1580001, Japan, and **Akio Arimoto**. *Some considerations of Poncelet's porism using elliptic functions.*

This study concerns with Poncelet's porism in a circle and an ellipse as well as two circles. First the well known Steiner's relation for a bicentric pentagon which is inscribed and circumscribed in two circles simultaneously had been induced by the projective geometry so far but we develop the same relation analytically using Jacobi elliptic functions. Secondary we obtain the necessary and sufficient condition for a n -gon which is bicentric in a circle and an ellipse as well as two circles. Then we have the relations of the parameters of a circle and an ellipse for n -gons ($n \leq 7$). We prove that these relations are the necessary and sufficient conditions for the bicentric n -gons.

Also we study the "extended" porism in addition to the "normal" or "conventional" porism. The conventional porism means that a n -gon is created by making a round of a circle(or ellipse) from any starting point on the outside conic. The "extended" porism denotes that a n -gon is created by making multiple rounds of a circle(or ellipse). We show the fact that there exist the extended porisms in $n \geq 5$ and the relations of the parameters of conics are presented. (Received October 08, 2011)

34 ► *Ordinary differential equations*

1078-34-349 **Robert Buckingham***, Department of Mathematical Sciences, The University of Cincinnati, P.O. Box 210025, Cincinnati, OH 45221, and **Peter D. Miller**. *Asymptotics of rational Painlevé II solutions.*

The nonhomogenous Painlevé II equation has exactly one rational solution for specific values of the nonhomogenous term α . The real zeros of these rational functions have recently been shown to play an important role in a certain double-scaling limit for small-dispersion solutions of the sine-Gordon equation. Clarkson and Mansfield observed that the complex zeros (or poles) of the rational Painlevé II functions appear to have a highly regular triangular structure. We prove that, in the large- α limit, the scaled zeros (or poles) fill out a certain curvilinear triangular region in the complex plane. We also discuss progress on computing the leading-order asymptotic behavior of the rational solutions inside, outside, and at the edge of this root region. (Received December 13, 2011)

1078-34-351 **João P. F. Teixeira*** (jteix@math.ist.utl.pt), Av. Rovisco Pais, 1049-001 Lisboa, Portugal. *Existence of periodic solutions of ordinary differential equations.*

We prove a general result of existence of a periodic solution, $y \in C^1(\mathbb{R}, \mathbb{R}^l)$, of a first order differential equation $\dot{y} = f(t, y)$, where f is periodic with respect to t and admits a star-shaped compact set that is invariant under the Euler iterates of the equation with sufficiently small time-step. As in Peano's Theorem for the Cauchy problem, the only required regularity condition on f is continuity. We present two nontrivial examples that illustrate the usefulness of this theorem in applications related to forced oscillations.

We also discuss a generalization of this result to delay differential equations of the type $\dot{y} = f(t, y, y(t - T))$, under similar conditions on f . (Received December 13, 2011)

35 ► *Partial differential equations*

1078-35-5 **Vincent Ervin, William Layton** and **Monika Neda*** (monika.neda@unlv.edu). *Numerical analysis and computations of filter based stabilization for Navier-Stokes equations.*

We consider filter based stabilization for the Navier-Stokes equations. The first method we consider is to advance in time one time step by a given method and then to apply an (uncoupled and modular) filter to get the approximation at the new time level. This filter based stabilization, although algorithmically appealing, is viewed in the literature as introducing far too much numerical dissipation to achieve a quality approximate solution. We show that this is indeed the case. We then consider a modification: Evolve one time step, Filter, Deconvolve then Relax to get the approximation at the new time step. We give a precise finite element analysis of the numerical diffusion and error in this process and show it has great promise, confirmed in several numerical benchmark problems. (Received July 13, 2011)

- 1078-35-57 **Mark A. Hoefler*** (mahoefer@ncsu.edu), Department of Mathematics, North Carolina State University, Box 8205, Raleigh, NC 27695, and **Matteo Sommacal**, School of Computing, Engineering, Info. Sci., Northumbria University, Newcastle, England.
Perturbed magnetic droplet solitons.

The (1+1)-dimensional Landau-Lifshitz equation with uniaxial anisotropy admits a two-parameter family of soliton solutions called magnetic droplets. Recent work demonstrates the physical relevance of these coherent structures when perturbed by weak damping, a slowly varying external magnetic field, and spin torque. Perturbed droplet dynamics encompassing these physical effects are studied in the context of soliton perturbation theory, made particularly explicit by the integrability of the unperturbed problem. The resulting finite dimensional modulation system describes the slow evolution of the perturbed soliton's speed and frequency. A detailed dynamical systems analysis yields a number of interesting physical effects. Asymptotic results are corroborated by direct numerical simulations of the full partial differential equation. (Received November 16, 2011)

- 1078-35-86 **Boaz Ilan*** (bilan@ucmerced.edu), School of Natural Sciences, University of California, Merced, Merced, CA 95343, and **Mark A Hoefler** (mahoefer@ncsu.edu), Department of Mathematics, North Carolina State University, Raleigh, NC 27695. *Transverse instabilities of dark solitons and dispersive shocks.*

Transverse instabilities of dark solitons for the (2+1)-dimensional defocusing nonlinear Schrödinger / Gross-Pitaevskii equation are considered. Asymptotics and computations of the eigenvalues of the linearized equation yield the maximum growth rate of unstable perturbations. The separatrix between convective and absolute instabilities is found and used for studying the transition between convective and absolute instabilities of stationary and non-stationary oblique dispersive shock waves in the shallow and hypersonic regimes. These results have application to controlling nonlinear waves in dispersive media, such as dispersive shocks in Bose-Einstein condensates and nonlinear optics. (Received November 22, 2011)

- 1078-35-95 **Hao Fang***, 14 McLean hall, Iowa City, IA 52242, and **Mijia Lai** (lai@math.rochester.edu). *Inverse σ_k flow on Kahler manifolds with symmetry.*

In this talk, we will discuss the behavior of the inverse σ_k flow, which includes the J-flow as a special case, on a Kahler manifold with symmetry. Of particular interest is the case in which the flow blows up at the infinite time. Geometrically, it is equivalent to a partial blow-down of the manifold; while analytically, it is closely related to the obstacle problem in the elliptic PDE theory. (Received November 25, 2011)

- 1078-35-98 **Andrea Louise Bertozzi*** (bertozzi@math.ucla.edu), 520 Portola Plaza, Department of Mathematics, UCLA, Los Angeles, CA 90095, and **Thomas Boris Laurent** and **Flavien Leger**. *Aggregation via the Newtonian potential and aggregation patches.*

This paper considers the multidimensional active scalar problem of motion of a function $\rho(x, t)$ by a velocity field obtained by $v = -\nabla N * \rho$, where N is the Newtonian potential. This problem has connections to vortex dynamics for 2D fluids only the velocity field is a gradient flow rather than divergence free. We prove well-posedness of compactly supported $L^\infty \cap L^1$ solutions of possibly mixed sign. These solutions include an important class of solutions that are proportional to characteristic functions on a time-evolving domain. We call these aggregation patches because of their connection to classical vortex patches in fluid dynamics. Whereas positive solutions collapse on themselves in finite time, negative solutions spread and converge toward a self-similar spreading circular patch solution as $t \rightarrow \infty$. We give a convergence rate that we prove is sharp in 2D. In the case of positive collapsing solutions, we investigate numerically the geometry of patch solutions in 2D and in 3D (axisymmetric). We show that the time evolving domain on which the patch is supported typically collapses on a complex skeleton of codimension one. (Received November 26, 2011)

- 1078-35-115 **Maria P Gualdani*** (gualdani@math.utexas.edu), 1 University Station C1200, Austin, TX 78712. *A factorization method for non-symmetric linear operator: enlargement of the functional space while preserving hypo-coercivity.*

We present a factorization method for non-symmetric linear operators: the method allows to enlarge functional spaces while preserving spectral properties for the considered operators. In particular, spectral gap and related convergence towards equilibrium follow easily by hypo-coercivity and resolvent estimates. Applications of this theory on several kinetic equations will be presented. This is a joint work with Stephane Mischler and Clement Mouhot. (Received November 29, 2011)

1078-35-132 **Robert Marangell*** (r.marangell@sydney.edu.au), School of Mathematics and Statistics F07, University of Sydney, NSW 2006, Australia, Sydney, NSW 2006, Australia, and **C.K.R.T. Jones, P. Miller** and **R. Plaza**. *The spectrum of periodic traveling waves in the sine-Gordon equation.*

Traveling wave solutions to the sine-Gordon equation can be organized according to their speed (sub or superluminal), and the phase plane of the pendulum equation. From this one can obtain four cases for which the linearized sine-Gordon operator is spatially periodic. Determining linearized stability then amounts to finding special solutions to a Hill's equation. In this talk, I will relate the spectrum of the linearized sine-Gordon operator to said Hill's equation, and use the prevailing Hill's equation theory to establish the linearized stability or instability of each case. (Received December 01, 2011)

1078-35-164 **Paul Smith*** (smith@math.berkeley.edu), Department of Mathematics, University of California, Berkeley, 970 Evans Hall, Berkeley, CA 94720-3840. *Global regularity of energy-critical Schrödinger maps: sub-threshold dispersed energy.*

We consider the Schrödinger map initial value problem

$$\begin{cases} \partial_t \phi &= \phi \times \Delta \phi \\ \phi(x, 0) &= \phi_0(x), \end{cases}$$

with $\phi_0 : \mathbf{R}^2 \rightarrow \mathbf{S}^2 \hookrightarrow \mathbf{R}^3$ a smooth H_Q^∞ map from the Euclidean space \mathbf{R}^2 to the sphere \mathbf{S}^2 . Given energy-dispersed data ϕ_0 with subthreshold energy, we prove that the Schrödinger map system admits a unique global smooth solution $\phi \in C(\mathbf{R} \rightarrow H_Q^\infty)$. Global-in-time bounds on certain Sobolev norms of ϕ are also established as a consequence of the proof. Key ingredients in the proof are improved local smoothing and bilinear estimates, which we obtain by adapting the Planchon-Vega approach to such estimates to the nonlinear (or linear covariant) setting of Schrödinger maps. (Received December 05, 2011)

1078-35-178 **Anthony M Bloch*** (abloch@umich.edu), Dept. of Mathematics, University of Michigan, 530 Church Street, Ann Arbor, MI 48109. *Integrable systems, gradient flows, and dissipation.*

In this talk I will discuss the dynamics and geometry of various integrable systems that exhibit asymptotic stability and dissipative behavior, as well as dissipative perturbations of integrable systems. Examples include the finite Toda lattice, the dispersionless Toda partial differential equation, certain nonholonomic systems, certain Monge-Ampere equations and wave equations with dissipation. I will describe the geometric structures, including metric and complex structures, that give rise to some of these flows and determine their behavior. This includes work with P. Morrison and T. Ratiu. (Received December 06, 2011)

1078-35-219 **Zaher Hani*** (hani@cims.nyu.edu), 251 Mercer Street, New York, NY 10012. *Long-time behaviour of some non-linear Schrödinger flows.*

We compare the long-time behavior of the flow for some nonlinear Schrödinger equations and examine some effects of the geometry of the underlying domain and the resonances of the equation on the global picture. (Received December 08, 2011)

1078-35-220 **Jacob Sterbenz*** (jsterben@math.ucsd.edu), **Joachim Krieger** and **Daniel Tataru**. *Critical regularity for the Maxwell-Klein-Gordon equation.*

We discuss recent work on regularity for the (4+1) dimensional Maxwell-Klein-Gordon with initial data small in the energy space. The proof employs some new estimates for parametrices of magnetic wave equations in Bourgain type spaces. (Received December 09, 2011)

1078-35-225 **Ioan Bejenaru** and **Daniel Tataru*** (tataru@math.berkeley.edu). *Near soliton dynamics in Wave and Schrodinger Maps.*

I will provide an overview of current work concerning the long time dynamics of near soliton solutions in two dimensional energy critical wave and Schrodinger maps. (Received December 09, 2011)

1078-35-234 **Peter Constantin**, Princeton University, Fine Hall, Washington Road, Princeton, NJ 08544, and **Vlad C Vicol*** (vicol@math.uchicago.edu), University of Chicago, 5734 University Avenue, Chicago, IL 60637. *Global regularity for critical active scalar equations.*

We present a new proof of global well-posedness for the critical surface quasi-geostrophic equation. The main ingredient is a nonlinear lower bound for linear non-local operators, when evaluated at extrema. (Received December 09, 2011)

1078-35-247 **mimi dai*** (mdai@slugmail.ucsc.edu), **jie qing** and **maria schonbek**. *Asymptotic behavior of solutions to Liquid Crystal systems in the whole space \mathbb{R}^3 .*

In this paper we study the asymptotic behavior for solutions to a nematic liquid crystals system in the whole space \mathbb{R}^3 . The fluid under consideration has constant density and small initial data. The main ingredient to derive decay is Fourier splitting method which was originally introduced by M. Schonbek to study the large time behavior of solutions to Navier-Stokes equations. The asymptotic behavior of solutions to systems of nematic liquid crystals, on bounded domains with constant fluid density has been studied by several other authors using different methods. (Received December 10, 2011)

1078-35-272 **Juhi Jang*** (juhi.jang@math.ucr.edu), Department of Mathematics, University of California, Riverside, CA 92521. *Derivation of Magnetohydrodynamic equations from Vlasov-Maxwell-Boltzmann system.*

We introduce various scalings to the Vlasov-Maxwell-Boltzmann system of two species which formally lead to Magnetohydrodynamic (MHD) type equations with the corresponding Ohm's law in the limit. The results will cover the compressible resistive MHD equations, incompressible MHD equations for both viscous and inviscid cases. Hall effect will be also discussed. (Received December 12, 2011)

1078-35-277 **Gabriel S. Koch*** (g.koch@sussex.ac.uk), Brighton, England, **Isabelle Gallagher**, Paris, France, and **Fabrice Planchon**, Nice, France. *"Beyond L^3 ": a dispersive-type approach to Navier-Stokes regularity criteria in critical spaces.* Preliminary report.

We use the dispersive method of "critical elements" established by C. Kenig and F. Merle to give an alternative proof and generalization of a well-known Navier-Stokes regularity criterion due to L. Escauriaza, G. Seregin and V. Sverak, namely that 3-d solutions for which the spatial L^3 -norm of the velocity remains bounded in time cannot develop a singularity. Their result came as the difficult "endpoint" of a range of regularity criteria due to J. Serrin. Our techniques can be used to show that a range of weaker Besov norms must also become unbounded near a singularity. The key tool in our proof is a decomposition into "profiles" of bounded sequences in critical spaces (e.g., L^3). (These tools also generalize a recent result of W. Rusin and V. Sverak on "minimal blow-up data" for Navier-Stokes.) This is joint work with I. Gallagher and F. Planchon, and is based on an earlier joint work with C. Kenig. (Received December 12, 2011)

1078-35-284 **David Hoff**, Bloomington, IN, and **Misha Perepelitsa*** (misha@math.uh.edu), Houston, TX 77096. *Boundary tangency for density interfaces in compressible viscous fluid flows.*

In this talk we show that, for solutions of the Navier-Stokes equations of two-dimensional, viscous, compressible flow, curves which are initially transverse to the spatial boundary and across which the fluid density is discontinuous become tangent to the boundary instantaneously in time. This effect is seen to result from the strong pressure gradient force, which in this case includes a vector measure supported on the curve, together with the fact that singularities in this system are convected with the fluid velocity. (Received December 12, 2011)

1078-35-293 **Benjamin G Dodson*** (benjadod@math.berkeley.edu). *Global well-posedness and scattering for critical nonlinear Schrödinger equations.*

In this talk we study the initial value problem

$$\begin{aligned} iu_t + \Delta u &= F(u), \\ u(0, x) &= u_0 \in L^2(\mathbf{R}^d). \end{aligned} \tag{1}$$

Where $F(u) = \mu|u|^{4/d}u$, $\mu = +1$. We will show that (1) is globally well-posed and scattering for $u_0 \in L^2(\mathbf{R}^d)$. We will also discuss how the same techniques can be used in the study of the defocusing initial value problem

$$\begin{aligned} iu_t + \Delta u &= |u|^2u, \\ u(0, x) &= u_0 \in \dot{H}_0^1(\Omega), \end{aligned} \tag{2}$$

with Dirichlet boundary conditions $u|_{\partial\Omega} = 0$, $\Omega = \mathbf{R}^4 \setminus \Sigma$, where Σ is a convex obstacle. (Received December 12, 2011)

1078-35-303 **Peter David Miller*** (millerpd@umich.edu), East Hall, 530 Church St., Ann Arbor, MI 48109. *On the modified nonlinear Schrödinger equation in the semiclassical limit.*

The modified nonlinear Schrödinger (MNLS) equation is a completely integrable system that appears to be a perturbation of the focusing nonlinear Schrödinger (NLS) equation. However, the perturbation is singular and it turns out that one of its effects is that for certain initial data the problem behaves more like a perturbed defocusing NLS equation than a perturbed focusing NLS equation. This effect is particularly dramatic in

the semiclassical limit, in which it can be seen that the modulational instability of the unperturbed problem completely disappears in the perturbed problem for certain initial conditions. This is joint work with Jeffery DiFranco and Benson Muite. (Received December 12, 2011)

1078-35-317 **Anna L Mazzucato*** (alm24@psu.edu). *Boundary layer analysis for certain 3D nonlinear flows.*

We prove optimal convergence rates in viscosity of Navier-Stokes solutions to Euler solutions for certain classes of 3D non-linear channel and pipe flows using effective equations for flow correctors. This is joint work with Daozhi Han, Dongjuan Niu, and Xiaoming Wang. (Received December 12, 2011)

1078-35-320 **Anna L Mazzucato*** (alm24@psu.edu). *An existence result for a fluid-structure interaction model.*

We give a sharp trace regularity result for the system of anisotropic elasticity and use it to obtain a new existence result for a fluid-structure interaction model in the case when the structure is an anisotropic elastic body. This is joint work with Igor Kukavica and Amjad Tuffaha. (Received December 12, 2011)

1078-35-321 **Jeffery C DiFranco*** (difranco@seattleu.edu), Department of Mathematics, 901 12th Ave, P.O. Box 222000, Seattle, WA 98122, and **Peter Miller**. *Inverse scattering for the semiclassical modified nonlinear Schrödinger equation.*

The modified nonlinear Schrödinger equation (MNLS) has the interesting feature that, depending on the initial conditions, it can behave like the focusing nonlinear Schrödinger equation, the defocusing nonlinear Schrödinger equation or an interesting mixture of the two. In this talk I will discuss some of these features and, in particular, speak about the role of these characteristics in obtaining semi-classical asymptotics through inverse scattering using the Deift-Zhou steepest descent analysis for Riemann-Hilbert problems. (Received December 12, 2011)

1078-35-325 **Susan Friedlander*** (susanfri@usc.edu), Math Dept, USC, Los Angeles, CA 90089, and **Walter Rusin** (wrusin@usc.edu) and **Vlad Vicol** (vicol@math.uchicago.edu). *An active scalar equation with supercritical fractional diffusion.*

We address the well/ill posedness of the magnetogeostrophic equation with supercritical fractional diffusion. There is a striking loss of regularity when the fractional power drops below $1/2$. This happens because the constitutive law used to obtain the velocity from the active scalar is given by an unbounded Fourier multiplier which is both even and anisotropic. (Received December 12, 2011)

1078-35-342 **Alexei Rybkin*** (arybkin@alaska.edu), Department of Math and Statistics, University of Alaska Fairbanks, Fairbanks, AK 99775. *On the Cauchy problem for the KdV equation with Miura type initial data.*

We are concerned with the KdV equation with Miura type singular initial profiles. In particular we show that the KdV flow evolves any real singular initial profile q of the form $q = r' + r^2$, where $r \in L^2_{loc}$, $r|_{\mathbb{R}_+} = 0$ into a meromorphic function with no real poles. The talk is based on joint research with Sergei Grudsky. (Received December 13, 2011)

1078-35-343 **Thomas Chen** and **Natasa Pavlovic***, Department of Mathematics, University of Texas at Austin, 1 University Station, C 1200, Austin, TX 78712. *A new derivation of the Gross-Pitaevskii Hierarchy.*

The Gross-Pitaevskii (GP) hierarchy is an infinite system of coupled linear non-homogeneous PDEs, which appear in the derivation of the nonlinear Schrödinger equation (NLS). In this talk we will discuss a new derivation of the defocusing cubic GP hierarchy in dimensions $d = 2, 3$, from an N -body Schrödinger equation describing a gas of interacting bosons in the GP scaling, in the limit $N \rightarrow \infty$. In particular, we prove convergence of the corresponding BBGKY hierarchy to a GP hierarchy in the spaces introduced in our previous work on the well-posedness of the Cauchy problem for GP hierarchies, which are inspired by the solutions spaces based on space-time norms introduced by Klainerman and Machedon. We note that in $d = 3$, this has been a well-known open problem in the field. While our results do not assume factorization of the solutions, consideration of factorized solutions yields a new derivation of the cubic, defocusing NLS in $d = 2, 3$. (Received December 13, 2011)

1078-35-358 **Jacob Glenn-Levin***, University of Texas at Austin, Department of Mathematics, 1 University Station C1200, Austin, TX 78712. *Incompressible Boussinesq equations in borderline Besov spaces.*

I will discuss local-in-time existence and uniqueness for the incompressible Boussinesq equations. I assume the density equation has nonzero diffusion and that the initial data belongs in a Besov-type space B_Γ based upon the space $B_{\infty,1}^0$. (Received December 13, 2011)

1078-35-376 **Brian Wissman*** (wissman@hawaii.edu), Brian Wissman, University of Hawai'i at Hilo, Natural Sciences Division, Hilo, HI 96720. *Global solutions to the ultra-relativistic Euler equations.*

We show that when entropy variations are included and special relativity is imposed, the thermodynamics of a perfect fluid leads to two distinct families of equations of state whose relativistic compressible Euler equations are of Nishida type. (In the non-relativistic case there is only one.) The first corresponds to the Stefan-Boltzmann radiation law, and the other, emerges most naturally in the ultra-relativistic limit of a γ -law gas, the limit in which the temperature is very high or the rest mass very small. We clarify how these two relativistic equations of state emerge physically, and provide a unified analysis of entropy variations to prove global existence in one space dimension for the two distinct 3×3 relativistic Nishida-type systems. (Received December 13, 2011)

1078-35-382 **Boris Ettinger*** (ettinger@math.berkeley.edu), Department of Mathematics, University of California, Berkeley, 970 Evans Hall, Berkeley, CA 94720-3840. *Local well-posedness for the minimal hypersurface equation in Minkowski space-time.*

The minimal hypersurface equation for Lorentzian hypersurfaces of the Minkowski space-time is a quasi-linear wave equation. The equation exhibits a cancellation known as a null condition. Smith and Tataru established the sharp regularity result for a general quasi-linear wave equation. We will explain how their strategy in tandem with the null condition can be used to lower the regularity of the initial data required for the well-posedness of the minimal hypersurface equation. (Received December 13, 2011)

1078-35-384 **Baoping Liu*** (baoping@math.berkeley.edu). *Low regularity solution for Chern-Simons-Schrödinger system.*

The Chern-Simons-Schrödinger system arises in physics as a model describing the second-quantized N-body anyon problem. Mathematically, it has some similarity to the Schrödinger map problem. By choosing a suitable gauge, and exploring bilinear estimates in finer scale, we obtain local wellposedness for solutions with low regularity. (Received December 13, 2011)

1078-35-385 **Alexey Cheskidov*** (acheskid@math.uic.edu), 322 SEO, 851 S. Morgan Street, Chicago, IL 60607. *A unified approach to regularity problems for the 3D Navier-Stokes and Euler equations: the use of Kolmogorov's dissipation range.*

Motivated by Kolmogorov's theory of turbulence we present a unified approach to the regularity problems for the 3D Navier-Stokes and Euler equations. In particular, we present a new regularity criterion in terms of the intermittency parameter representing the dimension of a dissipation set. This is a joint work with R. Shvydkoy. (Received December 13, 2011)

1078-35-389 **Vera Mikyoung Hur*** (verahur@math.uiuc.edu), 1409 W Green Street, Department of Mathematics, University of Illinois at Urbana-Champaign, Urbana, IL 61801, and **Jared Bronski** and **Nanjundamurthy Venkatasubbu**. *Modulational instability and variational structure.*

I will discuss the modulational stability and instability of periodic traveling-wave solutions to a Hamiltonian PDE with a certain algebraic structure. Examples include Burgers equations with fractional dispersion, such as the KdV and the Benjamin-Ono. Instead of relying on the traditional Evans function based approach, the theory is based on direct spectral perturbation. I will make a connection to the Benjamin-Feir instability of Stokes waves, if time permits. (Received December 13, 2011)

1078-35-393 **Daniel Coutand** and **Steve Shkoller*** (shkoller@math.ucdavis.edu), Department of Mathematics, University of California, Davis, CA 95616. *The splash singularity for the 3-D free-surface incompressible Euler equations.*

We prove that the 3-D free-surface incompressible Euler equations with regular initial geometries and velocity fields have solutions which can form a finite-time "splash" singularity, wherein the evolving 2-D hypersurface intersects itself at a point. (Received December 13, 2011)

1078-35-395 **Steve Shkoller*** (shkoller@math.ucdavis.edu), Department of Mathematics, University of California, Davis, CA 95616. *Well-posedness for the inviscid compressible MHD equations with free-boundary.*

We describe a new set of estimates that allow us to develop an existence theory for the free-boundary MHD equations in 3 space dimensions. This is joint work with D. Coutand and J. Grimm. (Received December 13, 2011)

1078-35-407 **Walter Rusin*** (wrusin@usc.edu). *Navier-Stokes equations, stability, and minimal perturbations of global solutions.*

It has been established that if some data in $\dot{H}^{1/2}$ lead to a singularity in the 3D Navier-Stokes equations, there are also initial data with the minimal $\dot{H}^{1/2}$ norm which produce a singularity and the set of such data is compact up to translations and the natural scaling of the equation. In this talk we analyze the connection between the latter and the issue of stability of global regular solutions. (Received December 13, 2011)

1078-35-409 **Walter Rusin*** (wrusin@usc.edu). *On regularity of solutions to the 3D Navier Stokes equations oscillating in one direction.*

We consider the three dimensional Navier-Stokes equations in an unbounded domain which is periodic in the third direction. In this talk we give a set of conditions on various quantities derived from the initial data, that, if satisfied, lead to global, regular solutions. (Received December 13, 2011)

37 ► *Dynamical systems and ergodic theory*

1078-37-11 **Suliman Albandik*** (suliman@uni-math.gwdg.de), Mathematisches Institut, Georg-August Universität Göttingen, Bunsenstr. 3-5, 37073 Göttingen, Germany. *KMS states on C*-algebras associated to self-similar groups.*

In Quantum statistical mechanics, KMS states are thermal equilibrium states associated to a one parameter group of automorphisms of time evolution. In this talk I shall consider the question of existence and uniqueness of KMS-states on Cuntz-Pimsner-type C*-algebras, due to Nekrashevych, which are naturally associated to self-similar groups and hence to dynamical systems. (Received December 14, 2011)

1078-37-25 **Hasina Akter*** (hasinaakter@my.unt.edu), Department of Mathematics, University of North Texas, 1155 Union Circle #311430, Denton, TX 76203, and **Mariusz Urbanski**. *Real analyticity of Hausdorff dimension of Julia sets of parabolic polynomial $f_\lambda(z) = z(1 - z - \lambda z^2)$.* Preliminary report.

Let D_0 denote the set of all parameters $\lambda \in \mathbf{C} \setminus \{0\}$ for which the cubic polynomial f_λ is parabolic and has no parabolic or finite attracting periodic cycles other than 0. We prove that D_0 contains a deleted neighborhood of the origin 0. Our main result is that the function $D_0 \ni \lambda \mapsto \text{HD}(J(f_\lambda)) \in \mathbf{R}$ is real-analytic. This function ascribes to the polynomial f_λ the Hausdorff dimension of its Julia set $J(f_\lambda)$. The theory of parabolic and hyperbolic graph directed Markov systems with infinite number of edges is used in the proofs. (Received October 19, 2011)

1078-37-51 **Mariusz Urbanski*** (urbanski@unt.edu), Mariusz Urbanski, Department of Mathematics, University of North Texas, Denton, TX 76203, and **Volker Mayer** and **Bartłomiej Skorulski**. *Distance expanding random mappings, thermodynamic formalism, Gibbs measures, and fractal geometry.*

In this talk we introduce measurable expanding random systems, present the appropriate form of thermodynamical formalism and establish, in particular, exponential decay of correlations and real analyticity of the expected pressure even though the spectral gap property does not hold. This theory is then used to investigate fractal properties of conformal random systems. We discuss a Bowen's formula and the multifractal formalism of the Gibbs states. Depending on the behavior of the Birkhoff sums of the pressure function we get a natural classification of the systems into two classes: quasi-deterministic systems which share many properties of deterministic ones and essential random systems which are rather generic and never bi-Lipschitz equivalent to deterministic systems. We show in the essential case that the Hausdorff measure vanishes which refutes a conjecture of Bogenschütz and Ochs. We finally give applications of our results to various specific conformal random systems and positively answer a question of Brück and Bürger concerning the Hausdorff dimension of random Julia sets. (Received November 12, 2011)

1078-37-58 **Yasuaki Hiraoka*** (hiraoka@imi.kyushu-u.ac.jp), Motooka, Fukuoka 819-0395, Japan. *Rational maps and maximum likelihood decoding: dynamical system and invariant theory in decodings.*

In this talk, we study the maximum likelihood (ML) decoding in error-correcting codes as a rational map and propose a new approximate ML decoding rule by using the Taylor expansion. The point for the Taylor expansion is properly chosen by considering some properties of the rational map dynamical systems. Our first result is a duality theorem. It shows a relationship between the algebraic structure of ML decoding and the minimum distance of the dual code. Through this duality theorem, we propose a new approximate ML decoding and also show some numerical results on its bit error probability. Moreover, we explain how the invariant theory allows us to develop a precise and practical approximation of ML decoding. (Received November 15, 2011)

1078-37-106 **Stéphane Seuret*** (seuret@u-pec.fr), LAMA UMR CNRS 8050, Université Paris-Est, 61 avenue du Général de Gaulle, 94010 Créteil, France. *Dimensions of fractals defined via the semi-group generated by 2 and 3.* Preliminary report.

We compute the Hausdorff and Minkowski dimension of subsets of the symbolic space Σ that are invariant under multiplication by a family of distinct primes p_1, p_2, \dots, p_d . It includes the sets $\{x \in \Sigma : \forall k, x_k x_{2k} \cdots x_{dk} = 0\}$. We prove that for such sets, the Hausdorff and Minkowski dimensions typically differ. This is a joint work with Y. Peres, B. Solomyak and J. Schmeling. (Received November 28, 2011)

1078-37-167 **Stephen R Muir*** (muirst@ucr.edu). *Thermodynamical formalism for a modified shift map.*

Some typical results in the thermodynamical formalism (specifically in the applications of transfer operators to Gibbs/equilibrium measures) are reproduced in a novel setting: the “alphabet” E is a compact metric space equipped with an *a priori* probability measure ν and an endomorphism T . The “modified shift map” is defined on the product space $E^{\mathbb{N}}$ by the rule $(x_1 x_2 x_3 \dots) \mapsto (T(x_2) x_3 \dots)$. The greatest novelty is found in the variational principle, where a term must be added to the entropy to reflect the transformation of the first coordinate by T after shifting. Our motivation is that this system, in its full generality, cannot be treated by the existing methods of either rigorous statistical mechanics of lattice gases (where only the true shift action is used) or dynamical systems theory (where the *a priori* measure is always implicitly taken to be the counting measure). (Received December 05, 2011)

1078-37-222 **Tony Samuel*** (swiss.tony.82@gmail.com). *Spectral metric spaces for Gibbs measures.*

The common idea of Connes’ Non-commutative Geometry is to represent a geometric object by an operator algebra and in doing so one is able to build an analogue of a differential structure for these operator algebras. Connes showed that the starting point in forming such a theory is to form a spectral triple.

In this talk we will show how one can construct a spectral triple which will represent a sub-shift of finite type Σ equipped with a Gibbs measure μ . Specifically, we will construct a spectral triple from which one can recover both the geometry of Σ as well as the measure μ . Since a sub-shifts of finite type can be used to represent a wide variety of fractal sets, the theory we will present will allow one to begin to describe an analogue of a differential structure for a wide class of fractal sets.

I will try to present the material so that no prior knowledge of non-commutative geometry will be required. (Received December 09, 2011)

1078-37-228 **Robert G Niemeyer*** (niemeyer@math.ucr.edu), 900 Big Springs Rd., Surge Building, Dept. of Mathematics, Riverside, CA 92521, and **Michel L Lapidus** (lapidus@math.ucr.edu), 900 Big Springs Rd., Surge Building, Dept. of Mathematics, Riverside, CA 92521. *On the properties of Koch snowflake prefractal billiard tables.*

In this talk, we will examine the properties of sequences of compatible orbits of Koch snowflake prefractal billiards, the corresponding geodesic flows on the associated flat surfaces and the associated groups of affine automorphisms of each flat surface (more generally known as the corresponding Veech groups). In particular, we discuss the dichotomous nature of a sequence of compatible orbits, finitely stabilizing periodic orbits and the potential for what we call infinitely stabilizing periodic orbits. In addition to this, we examine properties of the associated Veech group and discuss conjectures on the existence of a fractal flat surface and the corresponding Veech group. (Received December 09, 2011)

1078-37-255 **Tushar Das*** (tushardas.math@gmail.com). *Rigidity in infinite-dimensional hyperbolic spaces.*

We develop the theory of discrete groups acting by hyperbolic isometries on the open unit ball of an infinite-dimensional separable Hilbert space. We build appropriate analogs of thermodynamic formalism, ergodic theory and geometric measure theory to study the geometry of limit sets at the sphere at infinity.

We describe finitely and infinitely-generated classical Schottky groups which provide a rich abundance of examples that distinguish between finite and infinite-dimensional phenomena and present Sullivan-type rigidity for a large class of Schottky groups.

This is joint work with Bernd Stratmann (Bremen) and Mariusz Urbanski (UNT) (Received December 10, 2011)

1078-37-263 **Sabrina Kombrink*** (kombrink@math.uni-bremen.de). *Minkowski content of self-conformal sets in \mathbb{R}^d .*

The Minkowski content can be viewed as an analogue of the notion of volume for fractal sets. It carries information on the geometric structure of the underlying set and is capable of distinguishing between sets of the same “factual” dimension.

In this talk, we present conditions under which the Minkowski content is proven to exist for self-conformal sets, i. e. sets that arise as the invariant sets of conformal iterated function systems. Further, we show how the Minkowski content can be determined for this class of sets. (Received December 11, 2011)

41 ► *Approximations and expansions*

1078-41-22 **mahdi taheri*** (taheri@iauo-malayer.ac.ir), Department of mathematics, Islamic Azad University, Malayer branch, 65718/117 Malayer, Iran. *Approximate arithmetic operations on the fuzzy complex numbers using monotonic interpolation.*

We suggest the use of piecewise monotonic interpolations to approximate and represent a fuzzy complex number (orinterval) and to derive a procedure to control the absolute error associated to the arithmetic operations (+, −, •, :) between fuzzy complex numbers, in order to reduce the distance between the true result of the operation and its approximation. The monotonic functions are then used to define a parametric representation of a large class of fuzzy complex numbers having general shapes of the membership function and a simple and accurate procedure is introduced for the fuzzy arithmetic. Several computational experiments are given to show the good performance of the proposed procedure. (Received October 16, 2011)

1078-41-46 **Thomas C Hangelbroek*** (hangelbr@math.hawaii.edu), 2565 McCarthy Mall, Honolulu, HI 96822. *Boundary effects, the polyharmonic Dirichlet problem and non-intersecting lattice paths.*

A well known aspect of kernel approximation is the undesirably low saturation orders that come about in the presence of a boundary. These are easily observed numerically and have been demonstrated theoretically in the case of surface spline approximation. By using an approximation scheme based on a layer potential solution of a class of elliptic boundary value problems, these boundary effects can be overcome. In this talk, we will discuss the solution of the polyharmonic Dirichlet problem, which is key to overcoming the boundary effects. By focusing on the problem in a half space, we obtain an explicit, closed form solution related to a class of combinatorial problems: counting non-intersecting lattice paths. (Received November 09, 2011)

1078-41-49 **Natasha Flyer*** (flyer@ucar.edu), 1850 Table Mesa Dr., Boulder, CO 80307. *Radial Basis Functions: Developments and applications to planetary scale flows.*

Radial basis functions (RBFs) can be seen as a major generalization of pseudospectral methods, abandoning the orthogonality of the basis functions and in return obtaining much improved simplicity and geometric flexibility. Spectral accuracy becomes now easily available also when using completely unstructured node layouts, permitting local node refinements in critical areas. Computational cost and numerical stability were initially seen as potential difficulties, but major progress has recently been made also in these areas. The first major PDE applications for which RBFs have been shown to compete very successfully against the best current numerical approaches can be found in the geosciences. Examples that we describe here include vortex roll-ups, idealized cyclogenesis, unsteady nonlinear flows described by the shallow water equations, and 3-D convection in the earth’s mantle. (Received November 11, 2011)

1078-41-76 **J. D. Ward*** (jward@math.tamu.edu). *Kernel interpolation and approximation on manifolds.*

This talk will focus on kernel interpolation and approximation in a general setting. It turns out that for a wide class of compact, connected C^∞ Riemannian manifolds, including the important cases of spheres and $SO(3)$, the kernels obtained as fundamental solutions of certain partial differential operators generate Lagrange functions that are uniformly bounded and decay away from their center at a fast algebraic rate, and in certain cases, an exponential rate. This fact has important implications for interpolation, approximation and implementation of “cheap” computationally efficient bases, all of which will be discussed. The class of kernels considered in this talk include the restricted surface splines on spheres as well as surface splines for $SO(3)$, both of which have elementary closed form representations which are computationally implementable. The talk is based on some recent joint work with T. Hangelbroek, F.J. Narcowich, E. Fuselier, X. Sun and G. Wright. (Received November 21, 2011)

1078-41-150 **Xingping Sun*** (xsun@missouristate.edu), 901 S. National Ave, Springfield, MO 65897. *The decay rate of the Lagrange basis functions and its applications.*

In dealing with approximation problems on spheres or other manifolds involving scattered data, some kernels methods have been proven to be efficient. In many cases, one studies approximating an unknown function by a finite dimensional subspace spanned by shifts of a prescribed kernel function. Utilizing the Lagrange basis functions is advantageous. Recently, Hangelbroek and his co-authors have discovered a large class of kernels for which the Lagrange basis functions have desirable decay rates. In some case, these functions decay exponentially with respect to the minimal separation of the data points. As an immediate application of this result, they showed that the interpolation and the least square operators are L_∞ -bounded. In this presentation, we will show some further development in this direction. Among others, we will prove that a certain Bessel potential kernels also give rise to exponential decay of Lagrange basis functions. (Received December 04, 2011)

1078-41-179 **Francis J. Narcowich*** (fnarc@math.tamu.edu), Mathematics Department, Texas A&M University, College Station, TX 77843-3368. *Kernel-based Quadrature on Spheres and Homogeneous Spaces.*

The purpose of this talk is to discuss stable, accurate quadrature formulas for continuous functions defined on S^n , $SO(3)$, and for compact homogeneous manifolds in general. These formulas, which are derived by a method analogous to that used by Sommariva and Womersley for S^2 , employ a class of invariant positive definite and conditionally positive definite kernels defined on C^∞ Riemannian manifolds. These kernels were recently introduced and studied by E. Fuselier, T. Hangelbroek, F. J. Narcowich, X. Sun, J. D. Ward and G. Wright. The analysis of both the stability and accuracy of these formulas is based on the properties of these kernels. On S^2 , the class includes the (restricted) thin-pate splines. This talk represents joint work with several of the aforementioned colleagues. (Received December 06, 2011)

1078-41-190 **Quoc Thong Le Gia*** (qlgia@unsw.edu.au), School of Mathematics and Statistics, University of New South Wales, Sydney, NSW 2032, Australia, and **Kerstin Hesse**, Leipzig Graduate School of Management, Center for Advanced Studies in Management, Leipzig, Germany. *Numerical solutions to a boundary value problem on the sphere using radial basis functions.*

Boundary value problems on the unit sphere arise naturally in geophysics and oceanography when scientists model a physical quantity on large scales. In that situation, the curvature of the Earth cannot be ignored, and a boundary value problem has to be formulated on a subdomain of the unit sphere. For example, the study of planetary-scale oceanographic flows in which oceanic eddies interact with topography such as ridges and land masses or evolve in closed basin lead to the study of point vortices on the sphere with walls. Such vortex motions can be described as a Dirichlet problem on a subdomain of the sphere for the Laplace–Beltrami operator.

In this work, we construct approximate solutions to a boundary value problem on the unit sphere using radial basis functions via a collocation method. The error analysis between the exact solution and the approximation is provided. (Received December 06, 2011)

1078-41-243 **Edward J Fuselier*** (efuselier@highpoint.edu), Department of Mathematics & Computer Science, High Point University, 833 Montlieu Ave., High Point, NC 27262. *RBF-generated discrete differential operators on surfaces and applications to partial differential equations.*

A kernel-based method has recently been proposed for solving parabolic partial differential equations (PDEs) on surfaces. The method uses a semi-discrete approach by replacing the surface-differential operators that appear in the PDEs with discrete versions, which one constructs using kernel-based collocation. In this talk we discuss

how to produce these operators using radial basis functions (RBFs) and derive error estimates between each discrete differential operator and its continuous counterpart. We also present numerical results relevant to the efficacy of using these operators to solve certain parabolic PDEs, and end with some open questions. (Received December 10, 2011)

1078-41-309 **Christian Rieger*** (rieger@ins.uni-bonn.de), Wegelerstr. 6-8, 53115 Bonn, Germany. *Regularized reconstruction imposing sparsity constraints*. Preliminary report.

The main focus of this talk lies in the error analysis of regularized reconstruction algorithms. We discuss the reconstruction of an unknown function from a finite number of samples. Given an a priori chosen trial space, the reconstruction problem can be reformulated as a finite dimensional optimization problem, namely to find a vector representing an element from the trial space which fits best the unknown function. We propose an optimization problem based on the well-established compressed sensing techniques. In order to obtain well-posedness of the optimization problem, one needs certain properties of the trial space. It is known in the literature that spherical harmonics fit well into this framework and fulfill the necessary conditions.

In order to show convergence results for the function reconstruction, we need a quantification of the fact that small residuals of the algorithm imply small errors of the reconstruction process. This quantification is for the regularized reconstruction methods provided by sampling inequalities.

This is partly based on joint works with Barbara Zwicknagl. (Received December 12, 2011)

1078-41-311 **Barbara Zwicknagl*** (bzwick@andrew.cmu.edu). *Series kernels and some applications to reconstruction problems*.

In this talk we discuss approximation properties of series kernels. The latter are positive definite kernel functions that possess expansions in terms of simple basis functions. Typical examples of such basis functions include spherical harmonics, monomials, or wavelet-type function systems. The approximation properties of trial spaces built by translates of such series kernels are discussed. We focus on the interplay between the multiscale structure of the kernel and the choice of data points, and present applications ranging from multivariate polynomial approximation to the effective numerical solution of variational problems on manifolds.

This is partly based on joint works with M. Griebel, C. Rieger, and R. Schaback. (Received December 12, 2011)

1078-41-334 **Y C Hon*** (benny.hon@cityu.edu.hk), Department of Mathematics, City University of Hong Kong, Hong Kong, and **R Schaback**. *Harmonic kernels for solving Laplace equation on 3D domains*.

In this talk we present the recent development in using kernel-based approximation methods to solve the Laplace equation on domains in 3D by meshless collocation on scattered points of the boundary. Due to the use of new positive definite kernels, which are harmonic in both arguments and have no singularities, we can directly interpolate the solution on the boundary without the need of artificial boundary in the Method of Fundamental Solutions. In contrast to many other techniques, e.g. the Boundary Point Method or the Method of Fundamental Solutions, we provide a solid and comprehensive mathematical foundation which includes error bounds and works for general star-shaped domains. The convergence rates depend only on the smoothness of the domain and the boundary data. Some numerical examples will be demonstrated. (Received December 12, 2011)

1078-41-374 **Sergiy N Borodachov** (SBorodachov@towson.edu), Department of Mathematics, Towson University, Towson, MD 21252, **Douglas P Hardin*** (doug.hardin@vanderbilt.edu), Department of Mathematics, Vanderbilt University, Nashville, TN 37240, and **Edward B Saff** (edward.b.saff@vanderbilt.edu), Department of Mathematics, Vanderbilt University, Nashville, TN 37240. *Lightening the load: Low complexity discrete energy problems with varying weights*. Preliminary report.

We consider asymptotic (as $N \rightarrow \infty$) geometrical properties of N -point configurations $\{x_i\}_{i=1}^N$ on a d -rectifiable set A that minimize a *weighted Riesz s -energy* functional of the form

$$\sum_{i \neq j} \frac{w_N(x_i, x_j)}{|x_i - x_j|^s},$$

for a given ‘weight’ function w_N on $A \times A$ and a parameter $s > 0$.

In previous work, we described the asymptotic distribution for such problems when the weight w was a ‘CPD’ weight not depending on N . We extend these results to the case of N -dependent weights. In particular, we consider weights that lead to lower complexity energy calculations. (Received December 13, 2011)

1078-41-379 **J. Tyler Whitehouse*** (tyler.whitehouse@gmail.com), 1326 Stevenson Center, Nashville, TN 37240, and **Doug Hardin** (doug.hardin@vanderbilt.edu) and **Ed B. Saff** (edward.b.saff@vanderbilt.edu). *Quasi-uniformity of minimal weighted energy points on compact metric spaces.*

The problem of finding configurations that are optimally-distributed on a set appears in a number of guises including best-packing problems, coding theory, geometrical modeling, statistical sampling, radial basis approximation and golf-ball design. We consider the geometry of N -point configurations $\{x_i\}_{i=1}^N$ on a compact set A (with a metric m) that minimize a *weighted Riesz s -energy* functional of the form

$$\sum_{i \neq j} \frac{w(x_i, x_j)}{m(x_i, x_j)^s}$$

for a given weight function w on $A \times A$ and a parameter $s > 0$.

Specifically, if A supports an Ahlfors α -regular measure, we prove that whenever $s > \alpha$, any sequence of weighted minimal Riesz s -energy N -point configurations on A (for ‘nice’ weights) is quasi-uniform in the sense that the ratios of its mesh norm to separation distance remain bounded as N grows. Furthermore, if A is an α -rectifiable compact subset of Euclidean space with positive and finite α -dimensional Hausdorff measure, one may choose the weight w to generate a quasi-uniform sequence of configurations that have (as $N \rightarrow \infty$) a prescribed positive continuous limit distribution with respect to α -dimensional Hausdorff measure. This is joint work with E. Saff and D. Hardin. (Received December 13, 2011)

1078-41-403 **Y J Lee*** (leeyeonju08@gmail.com), Daejeon, South Korea, and **Y C Hon**. *Kernels method for solving inverse doping profile problem.*

In this talk we present a new meshless computational method by using special kernels for solving an inverse doping profile problem. Based on the use of fundamental solutions as special kernels, we successfully identify the unknown doped domains from incomplete Dirichlet and Neumann data given on part of the boundary. The uniqueness and stability results for the inverse doping profile problem will also be discussed. (Received December 13, 2011)

43 ► Abstract harmonic analysis

1078-43-6 **S. M mahmooudi*** (saeedmahmodi2060@yahoo.com), no 5 yase1 ammaryaser nirogah Qom Iran, 3713995345 Qom, Iran. *Sampling in Complex and Harmonic Analysis.*

Abstract. This is a survey article on uniqueness, sampling and interpolation problems in complex analysis. Most of these problems are motivated by applications of great practical importance in signal analysis and data transmission, but they also admit other mathematical formulations relating them to fundamental questions about existence of good bases in function spaces. This circle of ideas in complex analysis has experimented in recent years a notorious revitalization, mostly because of its connections with analogous problems in time-frequency and wavelet analysis, some of which will be discussed as well. (Received July 31, 2011)

46 ► Functional analysis

1078-46-9 **Mark Tomforde***, Department of Mathematics, 651 PGH, University of Houston, Houston, TX 77204-3008. *Classification of graph C^* -algebras and the Extension Problem.*

We discuss how K -theory provides complete stable isomorphism invariants for certain classes of nonsimple graph C^* -algebras. Moreover, we will show how this invariant can be calculated from data determined by the graph, and describe the range of the invariant. We explain how these results can be used to characterize when an extension of graph C^* -algebras is itself a graph C^* -algebra. (Received September 04, 2011)

1078-46-81 **Ritva Hurri-Syrjanen***, Department of Mathematics and Statistics, University of Helsinki, FI-00014 Helsinki, Finland, **Petteri Harjulehto**, Department of Mathematics, University of Turku, FI-20014 Turku, Finland, and **Antti V. Vahakangas**, Department of Mathematics and Statistics, University of Helsinki, FI-00014 Helsinki, Finland. *On the $(1, p)$ -Poincare inequality.*

We show that s -John domains support the $(1, p)$ -Poincare inequality for all finite $p > p_0$. We prove that the lower bound p_0 is sharp. (Received November 22, 2011)

1078-46-82 **Alexander A. Katz*** (katza@stjohns.edu), St. John's University, St. John's College of LAS, Dep. of Math & CS, 300 Hovard Ave., DaSilva Academic Center 314, Staten Island, NY 10301. *On nonstandard hulls of locally C^* -algebras.*

In the paper we outline a construction of the nonstandard hull of a locally C^* -algebra, and begin a systematic study of topics related to the question of how various notions in an internal locally C^* -algebra relate to the corresponding notions in the nonstandard hull of that algebra. (Received November 22, 2011)

1078-46-93 **Ionut Chifan** and **Thomas Sinclair*** (thomas.sinclair@math.ucla.edu). *Von Neumann algebras of hyperbolic groups.*

We will describe some operator-algebraic consequences of negative curvature phenomena in geometric group theory, with applications to the structural theory of II_1 factors and measured group theory. (Received November 23, 2011)

1078-46-204 **Nate Brown*** (nbrown@math.psu.edu), PA. *Analogies in the structure of W^* - and C^* -algebras.* Preliminary report.

I'll try to explain some recently observed analogies in the structure theory of simple operator algebras. (Received December 07, 2011)

1078-46-268 **Youngmi Hur** and **Amos Ron*** (amos@cs.wisc.edu), CS Department, 1210 West Dayton, Madison, WI 53706. *High-performance very local Riesz wavelet bases of $L_2(\mathbb{R}^d)$.*

We introduce new methodologies for the construction of high-performance very local Riesz wavelet bases of $L_2(\mathbb{R}^d)$ in arbitrarily high spatial dimension d . The localness L of the representation is measured as the sum of the volumes of the supports of the underlying mother wavelets; small localness number is one of the sought-for properties in wavelet constructions. Our constructs are very simple and they are based on the framelet construction methods known as the CAMP scheme and the L-CAMP scheme. Within our general methodology, the subclass of piecewise-constant constructions is the most local one. It includes Riesz wavelet bases with any performance grade and in any spatial dimension. In this subclass, the Riesz wavelet basis with Jackson-type performance k (namely, with k vanishing moments) has localness score $L < k + 1$, independently of the spatial dimension d . Thus, while the number of mother wavelets grows exponentially fast with the dimension, the sum of their volumes remains bounded. In comparison, the widely used d -dimensional tensor-product Daubechies' system with k vanishing moments has localness score $L \approx (4k - 2)^d$. (Received December 11, 2011)

1078-46-279 **Huaxin Lin*** (hlin@uoregon.edu), Department of Mathematics, Univerisity of Oregon, Eugene, OR 97402. *The Basic Homotopy Lemma and locally AH-algebras.*

We will discuss some back ground of the Basic Homotopy Lemma. In particular a version for approximately commuting unitaries. Several versions of the Basic Homotopy Lemma will be presented. We will also discuss new applications in the study of locally AH-algebras. (Received December 12, 2011)

1078-46-339 **Xiaoman Chen*** (xchen@fudan.edu.cn), N.220 Han Dan Road, Shanghai, Shanghai, Shanghai 200433, Peoples Rep of China. *Approximation properties of uniform Roe algebras.*

In this talk some approximation properties in uniform Roe algebras are discussed. It is well known that there is some continuous function in the circle which can not be approximated by its Fourier series uniformly, an example of such function was given by Fejer. In uniform Roe algebras, such phenomena is described in sense of that operators can not be approximated by the truncations of themselves. Lots of such examples are shown. Meanwhile, a sufficient condition is given for the operators which can be approximated by the truncations of themselves. In G -invariant case the G -invariant approximation property is defined, this means that any operator in the uniform G -invariant Roe algebra can be approximated by G -invariant operators with finite propagation. The following result is proved: Let X be a discrete metric space with bounded geometry, an amenable group G acts on X isometrically. If X has property A, then X has G -invariant approximation property. (Received December 13, 2011)

1078-46-345 **Will Gryc** (wgryc@muhlenberg.edu), Department of Mathematics, Muhlenberg College, 2400 W. Chew Street, Allentown, PA 18104, and **Todd Kemp*** (tkemp@math.ucsd.edu), Department of Mathematics, University of California, San Diego, 9500 Gilman Drive, La Jolla, CA 92093-0112. *Duality in Segal-Bargmann Spaces.*

The Segal-Bargmann space is the holomorphic L^2 space of Gaussian measure γ on \mathbb{C}^n . As a Hilbert space, it is (of course) self-dual. The corresponding holomorphic L^p spaces for $p \neq 2$ have more complicated duality relations. It has been known since the mid-80s that the dual to $L_{hol}^p(\gamma)$ can be identified with $L^{p'}(\gamma_p)$ for the conjugate exponent $\frac{1}{p} + \frac{1}{p'} = 1$ and a *dilated* Gaussian measure γ_p ; but this is not isometric.

Here we will present a tight estimate on constant of comparison between the dual norms. It grows exponentially fast with dimension n , leaving open many interesting questions about L^p Segal-Bargmann spaces in infinite-dimensions. The key to the proof is viewing $L^p_{hol}(\gamma)$ as a space of holomorphic sections over a (in this case trivial) vector bundle; this point of view shows why the dilation of the measure is natural, and translates the problem to the L^p -norm of an orthogonal projection. (Received December 13, 2011)

47 ► Operator theory

1078-47-12 **H. R. Cho*** (chohr@pusan.ac.kr), Department of Mathematics, Pusan National University, Pusa 609-735, South Korea, Busan, Busan 609-735, South Korea, and **B. R. Choe** and **H. Koo**. *Fock-Sobolev spaces of fractional order*.

We consider the Fock-Sobolev space F_s^p of fractional order consisting of entire functions f in \mathbb{C}^n such that $\mathcal{R}^{s/2}f$, the radial derivative of f of fractional order $s/2$, is in the Fock space F^p . We show that an entire function f is in F_s^p if and only if the F^p -norm of $|z|^s f(z)$ is finite. We also characterize the Carleson measures for the spaces F_s^p , establish the boundedness of the weighted Fock projection on appropriate L^p spaces, identify the Banach dual of F_s^p , and compute the complex interpolation space between two F_s^p spaces. (Received September 16, 2011)

1078-47-15 **Dragana S. Cvetkovic Ilic*** (dragana@pmf.ni.ac.rs). *Reverse order laws in C^* -algebras*. We present purely algebraic necessary and sufficient conditions for reverse order laws for generalized inverses in C^* -algebras, extending rank conditions for matrices and range conditions for Hilbert space operators. (Received September 20, 2011)

1078-47-54 **valentin matache*** (vmatache@mail.unomaha.edu), Department of Mathematics, University of Nebraska, Omaha, NE 68182. *Complex dynamics and the spectra of composition operators*.

In this talk we will address the consequences some classical theorems in complex dynamics have on the spectra of composition operators C_φ acting on H^2 , the Hilbert Hardy space of the unit disc. As a consequence of those classical theorems, one can find the spectra and essential spectra of select classes of composition operators by using an extra ingredient: the fact that the operator $C_\varphi^* C_\varphi$ is always asymptotically Toeplitz. (Received November 13, 2011)

1078-47-72 **Zeljko Cuckovic*** (zcuckovi@math.utoledo.edu), Department of Mathematics, University of Toledo, 2801 W. Bancroft St., Toledo, OH 43606, and **Trieu Le**, Department of Mathematics, University of Toledo, 2801 W. Bancroft St., Toledo, OH 43606. *Toeplitz operators on Bergman spaces of polyanalytic functions*.

We study algebraic properties of Toeplitz operators on Bergman spaces of polyanalytic functions on the unit disk. We obtain results on finite-rank commutators and semi-commutators of Toeplitz operators with harmonic symbols. (Joint work with Trieu Le). (Received November 20, 2011)

1078-47-163 **Maria Tjani*** (mtjani@uark.edu), 301 SCEN, 1 University of Arkansas, Fayetteville, AR 72701. *Closed range composition operators on Dirichlet type spaces*.

Given a holomorphic self map of the unit disk D we give necessary and sufficient conditions for the composition operator C_φ to be closed-range on holomorphic Besov spaces and more generally on Dirichlet type spaces. (Received December 07, 2011)

1078-47-189 **Hong Rae Cho**, **Boo Rim Choe*** (cbr@korea.ac.kr) and **Hyungwoon Koo**. *Linear sums of composition operators on the Fock-Sobolev spaces*. Preliminary report.

Linear sums of composition operators acting on the Fock-Sobolev spaces of several variables are studied. We show that such an operator is bounded only when all the composition operators in the combination are bounded individually. So, cancelation phenomenon is not possible on the Fock-Sobolev spaces, in contrast to what have been known on other well-known function spaces over the unit disk. We also show the analogues for compactness and the membership in the Schatten classes. In particular, compactness and the membership in some/all of the Schatten classes turn out to be the same. (Received December 06, 2011)

1078-47-402 **Jerome Kaminker*** (kaminker@math.ucdavis.edu), Department of Mathematics, UC Davis, Davis, CA 95616. *Higher spectral flow*.

Viewing $K^1(X)$ as made up of families of unbounded self-adjoint operators with compact resolvent, one is led to study how invariants such as the Chern character depend on the spectrum and eigenspaces. In particular, the

change in the multiplicity of eigenvalues as one moves around the parameter space X provides information on the K-theory class of the family. In a joint project with Ron Douglas we have been developing this point of view. The talk will explain some of the techniques used and apply them to classify families over closed 3-manifolds. Some relations to Berry phase and generalized characteristic classes, such as Spectral Flow and the Index Gerbe, will be discussed. (Received December 13, 2011)

51 ► Geometry

1078-51-109 **Reni Ivanova*** (rivanova@hawaii.edu), 200 W. Kawili Str., Hilo, HI 96720. *On the Weibull manifolds from a geometric point of view.*

In this study we present some of the main geometric characteristics of the Weibull manifolds such as geodesic distance, differential equations of geodesics, Gauss curvature, and scalar curvature. (Received November 28, 2011)

1078-51-112 **Ayaka Shimizu*** (shimizu1984@gmail.com), 3-3-138 Sugimoto, Sumiyoshi-ku, Osaka-shi, Osaka, 5588585, Japan. *Region crossing change on link diagrams.*

A region crossing change at a region of a link diagram is defined to be the crossing changes at all the crossing points on the boundary of the region. In this talk, we show that the region crossing change on a knot diagram is an unknotting operation, i.e., we can deform any knot diagram into a diagram of the trivial knot by region crossing changes. We also show properties of the region crossing changes on link diagrams. As an application, we introduce the game "Region Select" as a joint work with Akio Kawauchi and Kengo Kishimoto. (Received November 29, 2011)

1078-51-118 **Jianguo Sun*** (sunjg616@163.com), N5268 renming street changchun Jilin China, 130024. *The families of Gauss indicatrices on Lorentzian hypersurfaces in pseudo-spheres in semi-Euclidean 4 space.* Preliminary report.

We consider the one-parameter families of Gauss indicatrices on Lorentzian hypersurfaces in pseudo-sphere in semi-Euclidean 4 space with index 2 and give the singularities of the Lorentzian hypersurfaces by the contact theory. (Received November 29, 2011)

1078-51-138 **Hung Lu*** (hlu@hpu.edu), 1188 Fort Street Mall, suite 430, Honolulu, HI 96813, and **Michel L. Lapidus** and **Machiel van Frankenhuijsen**. *Explicit tube formulas for p -adic fractal strings.*

We present an explicit volume formula for the tubular neighborhood of a p -adic fractal string \mathcal{L}_p , expressed in terms of the underlying complex dimensions. The general tube formula is illustrated by some simple examples, the nonarchimedean Cantor, Euler, and Fibonacci strings. (Received December 02, 2011)

1078-51-177 **Gabor Szekelyhidi*** (gszekely@nd.edu), University of Notre Dame, 255 Hurley, Notre Dame, IN 46556. *Blowing up extremal Kahler manifolds.*

Starting with a manifold which admits an extremal Kahler metric, we construct extremal metrics on the blowup, sharpening results of Arezzo-Pacard-Singer. When the base manifold admits a Kahler-Einstein metric, then this gives a necessary and sufficient condition for the blowup in a single point to admit a constant scalar curvature Kahler metric, as long as the exceptional divisor is sufficiently small. (Received December 06, 2011)

1078-51-254 **Zair Ibragimov*** (zibragimov@fullerton.edu), 800 N. State College Blvd., MH 154, Fullerton, CA 92831. *Hyperbolization of metric spaces.*

It was proved by M. Bonk, J. Heinonen and P. Koskela that the quasihyperbolic metric hyperbolizes (in the sense of Gromov) uniform metric spaces. In this paper we introduce a new metric that hyperbolizes all locally compact noncomplete metric spaces. The metric is generic in the sense that (1) it can be defined on any metric space; (2) it preserves the quasiconformal geometry of the space; (3) it generalizes the j -metric, the hyperbolic cone metric and the hyperbolic metric of hyperspaces; and (4) it is quasi-isometric to the quasihyperbolic metric of uniform metric spaces. In particular, the Gromov hyperbolicity of these metrics also follows from that of our metric. (Received December 10, 2011)

1078-51-258 **Hiroaki Ishida*** (ishida@sci.osaka-cu.ac.jp). *Torus actions on complex manifolds.*

When a compact torus T acts effectively on a connected smooth manifold M having a fixed point, it follows from the isotropy representation at a fixed point that $\dim T \leq \frac{1}{2} \dim M$. The extreme case when $\dim T = \frac{1}{2} \dim M$ is most interesting. A. Hattori and M. Masuda introduced the notion of torus manifold. A *torus manifold* is

a connected closed oriented manifold of even dimension, say $2n$, with an effective $(S^1)^n$ -action having a fixed point. In this talk, we will focus on a torus manifold equipped with an invariant complex structure. We will see that such a torus manifold is equivariantly biholomorphic to a non-singular complete toric variety. This is a joint work with Yael Karshon. (Received December 11, 2011)

52 ► Convex and discrete geometry

1078-52-227 **A V Bondarenko** (andriybond@gmail.com), Department of Mathematics, National Taras Shevchenko University, Kyiv, Ukraine, **D P Hardin** (doug.hardin@vanderbilt.edu), Department of Mathematics, Vanderbilt University, Nashville, TN 37240, and **E B Saff*** (edward.b.saff@vanderbilt.edu), Department of Mathematics, Vanderbilt University, Nashville, TN 37240. *Quasi-uniformity of best-packing configurations*. Preliminary report.

Let A be a compact infinite metric space with metric m and let $\omega_N = \{x_i\}_{i=1}^N \subset A$ denote a configuration of $N \geq 2$ points in A . The *separation distance* of ω_N is

$$\delta(\omega_N) := \min_{1 \leq i \neq j \leq N} (x_i, x_j),$$

and the *mesh norm* (covering radius) of ω_N with respect to A is

$$\rho(\omega_N, A) := \max_{y \in A} \min_{1 \leq i \leq N} (y, x_i).$$

An N -point *best-packing configuration* ω_N^* is a configuration such that

$$\delta_N(\omega_N^*) := \max\{\delta(\omega_N) : \omega_N \subset A, |\omega_N| = N\}.$$

We investigate upper and lower bounds for the *mesh-separation ratio* (or *mesh-ratio*)

$$\gamma(\omega_N^*, A) := \rho(\omega_N^*, A) / \delta(\omega_N^*).$$

Furthermore, we study this quantity for best-packing configurations that are the limits of N -point minimal Riesz s -energy configurations. For the sphere $S^2 \subset \mathbb{R}^3$ we show that for $N = 5$ the limit of such s -energy configurations as $s \rightarrow \infty$ is the pyramid with square base (the 5-point best-packing configuration that has the maximum number of equal-distance pairs). (Received December 09, 2011)

53 ► Differential geometry

1078-53-1 **Zhiqin Lu*** (zlu@uci.edu), Department of Mathematics, UC Irvine, Irvine, CA 92697. *Geometry of Calabi-Yau moduli*.

In this talk, I will give an essentially self-contained introduction to the moduli space of Calabi-Yau manifolds (CY moduli).

The Weil-Petersson metric on the moduli space plays an important role. I will begin with the local theory, and using the local theory to study the global geometry of the moduli space. I will emphasize on the Gauss-Bonnet theorem, Chern numbers, etc, on CY moduli. The upshot is, even though we don't know the degenerations of CY manifolds, we are still able to define these topological invariants on the moduli space.

This talk contains some joint works with Michael R. Douglas, H. Fang, X. Sun, and K-I. Yoshikawa. (Received November 28, 2011)

1078-53-2 **Peter Schröder***, ps@cs.caltech.edu. *Conformal editing of surface meshes*.

In geometric modeling we aim to shape a surface so as to achieve a desired form. Such deformations can be quite general and preserve more or less of any existing structure. For example, in many computer graphics applications the surface is decorated with a texture which should distort gracefully along with the deformation of the surface. To achieve this we consider the class of conformal deformations, i.e., deformations which are locally rotations and uniform scales only (no unsightly shearing allowed). In this talk I will describe an approach to conformal deformations which is the first to require only the solution of a linear problem. It is based on a first order linear integrability condition which leads to sparse linear systems and computationally very attractive algorithms. (Received November 29, 2011)

1078-53-21 **Mohammed Abouzaid**, Clay Mathematics Institute and MIT, Cambridge, MA, **Denis Auroux*** (auroux@math.berkeley.edu), Department of Mathematics, UC Berkeley, 970 Evans Hall, Berkeley, CA 94720-3840, and **Ludmil Katzarkov**, Dept. of Mathematics, University of Miami, Coral Gables, FL. *Lagrangian fibrations on blowups of toric varieties and mirror symmetry for hypersurfaces*. Preliminary report.

This talk will focus on mirror symmetry for blowups of toric varieties from the perspective of the Strominger-Yau-Zaslow conjecture. Namely, we consider a certain Lagrangian torus fibration on the blowup of a toric variety along a codimension 2 subvariety contained in a toric hypersurface. This allows us to construct the SYZ mirror and its instanton corrections, and to provide an explicit description of the mirror Landau-Ginzburg model (up to higher order corrections). In this manner one can geometrically construct mirrors of essentially arbitrary hypersurfaces in toric varieties. We will focus on simple examples in low dimensions to explain the general construction. (Received October 13, 2011)

1078-53-53 **Bing Wang*** (bwang@scgp.stonybrook.edu), Simons Center of Geometry and Physics, Stony Brook University, Stony Brook, NY 11794-3636. *Kähler Ricci flow on log Del Pezzo surfaces*.

We develop some compactness theorem for the Kähler Ricci flow on log Del Pezzo surfaces. As application, we find some new Kähler Einstein metrics. (Received November 13, 2011)

1078-53-56 **Jian Song***, 310 Thornton Ct, Edgewater, NJ 07020, and **Gang Tian**. *Bounding scalar curvature for global solutions of the Kähler-Ricci flow*.

We show that the scalar curvature is uniformly bounded for the normalized Kähler-Ricci flow on a Kähler manifold with semi-ample canonical bundle. In particular, the normalized Kähler-Ricci flow has long time existence if and only if the scalar curvature is uniformly bounded, for Kähler surfaces, projective manifolds of complex dimension three, and for projective manifolds of all dimensions if assuming the abundance conjecture. (Received November 14, 2011)

1078-53-136 **Liang Chen*** (chenL234@nenu.edu.cn), Renmin street No. 5268, Changchun, Jilin 130024, Peoples Rep of China, **Shyuichi Izumiya** (Izumiya@math.sci.hokudai.ac.jp), Kita 10, Nishi 8, Kita-Ku, Sapporo, Hokkaido 060-0810, Japan, and **Masaki Kasedou** (Kasedou@math.sci.hokudai.ac.jp), Kita 10, Nishi 8, Kita-Ku, Sapporo, Hokkaido 060-0810, Japan. *Singularities of projective Gauss images of surfaces in Anti de Sitter 3-space*.

We investigate the geometrical properties of general compact surfaces in Anti de Sitter 3-space from the view point of Legendrian singularity theory. We define the projective Gauss image on the compact surface and study the geometric meanings of singularities of this map. As applications we study the contact of general compact surfaces with some model surfaces. (Received December 02, 2011)

1078-53-141 **Shyuichi Izumiya*** (izumiya@math.sci.hokudai.ac.jp), Department of Mathematics, Faculty of Science, Hokkaido University, Sapporo, 060-0810, Japan. *Lightlike geometry of spacelike surfaces in Minkowski space-time*. Preliminary report.

In [S. Izumiya and M. C. Romero Fuster, *Selecta Math.* NS 13 (2007),23–55], the lightlike geometry of codimension two spacelike submanifolds in Lorentz-Minkowski space was developed as an application of Lagrangian/Legendrian singularity theory. As a consequence, new invariants were discovered which are called *lightcone curvatures*. In this talk I will explain some topics related to those curvatures. Topics may include some of the followings:

- 1) Basic framework of lightlike geometry,
- 2) Marginally trapped surfaces,
- 3) Totally absolute lightcone curvatures and the lightcone Wilmore conjecture,
- 4) Spacelike knot theory for spacelike surfaces.

Although some of the above results hold in the general dimension, I will only explain the results for spacelike surfaces in Lorentz-Minkowski 4-space. (Received December 03, 2011)

1078-53-156 **Takashi Hashimoto*** (thashi@uec.tottori-u.ac.jp), 4-101, Koyama-Minami, Tottori, Tottori 6808550, Japan. *A twisted moment map and its equivariance*.

Let G be a linear connected complex reductive Lie group with Lie algebra \mathfrak{g} . Fixing λ in the dual of a Cartan subalgebra of \mathfrak{g} , take a parabolic subgroup Q of G whose Levi factor is the isotropy subgroup of λ in G , and $\{U_\sigma\}_\sigma$ the open covering of G/Q indexed by W/W_λ , where W_λ is the isotropy subgroup of λ in the Weyl group W . Then we construct holomorphic isomorphisms $\mu_{\lambda,\sigma}$ from T^*U_σ into $\Omega_\lambda := G.\lambda$ for σ , which will

become G -equivariant if we let G act on the bundles by affine transformation. Hence we glue $\{T^*U_\sigma\}$ together by transition functions induced from the affine action of G to form $T^*(G/Q)_\lambda$. It is locally isomorphic to the cotangent bundle, so we define local isomorphisms from $T^*(G/Q)_\lambda|_{U_\sigma}$ into Ω_λ by the same formula as $\{\mu_{\lambda;\sigma}\}$, which now satisfy the compatibility condition. Patching together $\mu_{\lambda;\sigma}$'s, we obtain an holomorphic isomorphism μ_λ from $T^*(G/Q)_\lambda$ onto Ω_λ . Moreover, this map preserves the symplectic forms on $T^*(G/Q)_\lambda$ and Ω_λ , which are naturally defined. (Received December 05, 2011)

1078-53-170 **Mark Gross*** (mgross@math.ucsd.edu), **Valentino Tosatti** and **Yuguang Zhang**. *Gromov-Hausdorff collapse for abelian fibred Calabi-Yau manifolds.*

We discuss recent results extending work of Gross-Wilson and Tosatti. Given an abelian fibration $f : M \rightarrow N$ with M a Calabi-Yau manifold and the general fibre of f an abelian variety, we consider the behaviour of suitably normalized Ricci-flat metrics with Kähler class approaching the pull-back of a Kähler class on N . Tosatti previously had proved a weak convergence in this situation; here, we prove a sufficiently strong convergence result which is enough to conclude Gromov-Hausdorff collapse, with a large subset of M collapsing to a large subset of N . (Received December 05, 2011)

1078-53-173 **Yu Zheng*** (zhyu@math.ecnu.edu.cn), 500 Dongchuan Road, Mathematics Department, East China Normal University, Shanghai, Shanghai 200241, Peoples Rep of China. *On the study of eigenvalue problems along the geometrical evolution equations.*

In this talk, we will introduced our recent works on the eigenvalue problems along the geometrical evolution equations. It will include the monotonicity related with the first eigenvalue along the Ricci flow, the local Lipschitz continuity of the first eigenvalue and the applications on Yamabe invariant along the general geometric flow. At last we will introduce one convexity invariance of the curvature operator and its applications along the Ricci flow. (Received December 05, 2011)

1078-53-231 **Qun Li*** (qun.li@wright.edu), **Damin Wu** and **Fangyang Zheng**. *An example of compact Kahler manifold with nonnegative quadratic bisectional curvature.*

In this talk, we will demonstrate the existence of a compact Kahler manifold with nonnegative quadratic bisectional curvature, which does not admit any Kahler metric of nonnegative orthogonal bisectional curvature. The manifold is a 7-dimensional Kahler C-space with second Betti number equal to 1, and its canonical metric is a Kahler-Einstein metric of positive scalar curvature. (Received December 09, 2011)

1078-53-248 **Jeff A Viaclovsky*** (jeffv@math.wisc.edu), Dept of Math Univ of Wisc, 480 Lincoln Drive, Madison, WI 53706. *Anti-self-dual deformations of Kahler scalar-flat ALE metrics.*

We will determine the dimension of the space of anti-self-dual deformations of a various Kahler scalar-flat ALE metrics in real dimension four. (Received December 10, 2011)

1078-53-252 **Aleksandar Subotic*** (asubotic@math.stanford.edu), Stanford Mathematics Department, Stanford University, Palo Alto, CA 94305. *On TCFT's on Weinstein manifolds.*

String topology and the recent work of Ganatra suggest that the wrapped Fukaya category should induce a field theory in the sense of Lurie, with the closed state spaces given by symplectic homology. I will discuss how this relates to the algebraic structure obtained from the Legendrian rational SFT of Bouregois, Ekholm, Eliashberg. (Received December 10, 2011)

54 ► General topology

1078-54-50 **Matt Insall**, **Peter A Loeb*** (loeb@math.uiuc.edu) and **Malgorzata Aneta Marciniak**. *End compactifications*. Preliminary report.

The title is not a political slogan. Simple examples of end compactifications are the two point compactification of the real line and the one point compactification of the complex plane. Our results apply to quite general connected and locally connected spaces. We are using the insights of Robinson's nonstandard analysis as a powerful tool to extend and simplify previous work of Hans Freudenthal and work on groups of Isaac Goldbring.

For the nonstandard extension of a metric space, the monad of a standard point x is the set of all points infinitely close to x . It is the intersection of the nonstandard extensions of all standard open sets containing x . This definition makes sense for non-metric spaces. Topological ends are equivalence classes of points that are not in such monads. This is the starting point that greatly simplifies the theory and illuminates various examples such as product spaces. (Received November 12, 2011)

1078-54-161 **Christian Laing*** (christian.laing@wilkes.edu), 578 Wyoming Avenue, Kingston, PA 18704. *The writhe of a polygon on the hexagonal closed packing*. Preliminary report.

We discuss the writhe of a self-avoiding polygonal curve on the hexagonal closed packing (HCP), a space group where the arrangement at each vertex has twelve nearest-neighbors. The writhe is computed as the average of weighted projected writhing numbers of the polygon in a few directions. These directions are determined by the HCP geometry, the weights are determined by areas of regions on the unit 2-sphere, and the regions are formed by the tangent indicatrix to the polygonal curve. The sphere partition given by the indicatrix is composed of 55 regions of 8 different types, including spherical triangles, quadrilaterals, rhombus, and a hexagon. (Received December 05, 2011)

1078-54-203 **Laura K Zirbel***, lzirbel@math.ucsb.edu. *Averages of Subsegment End to End Distance and Radius of Gyration in Ideal Rings*.

Classical results describe the scaling of end-to-end distance and radius of gyration for open and closed ideal chains. We extend these by giving formulae for the exact averages and include internal (or subsegment) scaling. They are used to study the effect of knotting on these characteristics of shape. (Received December 07, 2011)

1078-54-210 **Andrew Rechnitzer***, Department of Mathematics, UBC, Vancouver, BC V6T-1Z2, Canada, and **Buks van Rensburg**, Department of Mathematics and Statistics, York University, 4700 Keele Street, Toronto, On M3J-1P3, Canada. *Not quite universal*.

Self-avoiding polygons in 3d are perhaps one of the simplest ways to investigate random knotting. Recently there has been a great deal of work studying and cataloguing minimal length knotted conformations. I will describe work that Buks van Rensburg and I have done on minimal-length knotted polygons on three cubic lattices. More precisely I will talk about some of the different algorithms we have used to build our knot catalogues and some of the uses we have found for our data. In particular, I will talk about the writhe of minimal conformations and its not-quite-universality. (Received December 08, 2011)

1078-54-337 **Atsushi Takano*** (atakano@apchem.nagoya-u.ac.jp), Department of Applied Chemistry, Nagoya University, Nagoya, 464-8603, Japan. *Chain dimension of knotted and unknotted ring polystyrenes*.

Knotted ring polystyrene (PS) with high molecular weight ($M_w=380k$) was synthesized by intramolecular cyclization reaction in cyclohexane under diluted condition. Crude cyclization product was confirmed to include linear precursor molecule, single ring molecules, and various intermolecular-reacted byproducts by SEC and interaction chromatography (IC) characterizations. The crude product was fractionated several times by SEC and IC and finally highly purified knotted ring molecules were obtained. Furthermore the same cyclization reaction was also carried out in tetrahydrofuran to obtain unknotted ring and was purified by SEC and IC fractionations as well. SEC connecting with multi-angle laser light scattering and dynamic light scattering was used for the molecular characterization of the samples. It was found that the radii of gyration and hydrodynamic radii of the knotted ring polymers are evidently smaller than those of linear and the unknotted ring polymers, while knotted polymer molecules have the same absolute molecular weight as the corresponding counterparts. The chain dimensions of the both rings obtained were compared with those predicted by computer simulations. (Received December 12, 2011)

1078-54-350 **Kai Ishihara***, Department of Mathematics, Imperial College London, 180 Queens Gate South Kensington, London, England, and **Dorothy Buck**. *On nullification distance*.

The action of some site-specific recombinases can be modeled by a band surgery. Then we can consider the distance between two links in terms of coherent band surgeries. That is called nullification distance. In particular, the distance from an oriented link to an unlink is called the nullification number. Ernst-Montemayor-Stasiak enumerated the nullification number for all knots up to 9 crossings. The purpose of this talk is to give the table of the nullification distances between pairs of knots up to 7 crossings and two component links up to 6 crossings. We also discuss a relation between band surgery and rational tangle surgery. (Received December 13, 2011)

55 ► Algebraic topology

1078-55-205 **Robert D Little*** (little@math.hawaii.edu), Department of Mathematics, University of Hawaii at Manoa, 2565 McCarthy Mall, Honolulu, HI 96822. *Cyclic Cobordism of Surfaces and the Relative Class Number*.

A theorem of Ewing asserts that the image in a canonical group of algebraic integers of the cyclic cobordism group of surface maps of odd prime order under the equivariant signature is equal to the relative class number

of the odd prime. We extend this result and obtain an upper bound for this index in the case of maps of order a power of an odd prime. (Received December 07, 2011)

1078-55-274 **Dong Youp Suh*** (dysuh@math.kaist.ac.kr), Department of Mathematical Sciences, KAIST, 229 Daehakro, Yuseong-gu, Daejeon, 305-701, South Korea, and **Suyoung Choi** and **Seonjeong Park**. *Classification of quasitoric manifolds with the second Betti numbers equal to 2 and cohomological rigidity problem.*

In this talk we classify all quasitoric manifolds with the second Betti numbers equal to 2 up to homeomorphism. A quasitoric manifold is a topological analogue of a toric variety, which is a closed $2n$ -dimensional manifold with an n -dimensional torus action whose orbit space has the structure of a simple convex polytope of dimension n . The orbit space of a quasitoric manifold with the second Betti number 2 is a product of two simplices. Using the classification result we can prove that any two quasitoric manifolds with the second Betti number 2 are homeomorphic if and only if their cohomology rings are isomorphic. (Received December 12, 2011)

1078-55-299 **Alejandro Adem*** (adem@math.ubc.ca) and **Jose Gomez**. *Equivariant K-theory for actions with maximal rank isotropy.* Preliminary report.

Let G denote a compact connected Lie group with torsion-free fundamental group acting on a compact space X such that all the isotropy subgroups are connected and of maximal rank. Let T be a maximal torus with Weyl group W . We derive conditions on the induced action of W on the fixed-point set of T which imply that the equivariant K-theory of X is a free module over the representation ring of G . This can be applied to compute the equivariant K-theory of spaces of ordered commuting elements in certain compact Lie groups. This is joint work with J.M.Gomez. (Received December 12, 2011)

1078-55-365 **Chad Giusti** (giusti@willamette.edu), **Paolo Salvatore** (salvator@xp.mat.uniroma2.it) and **Dev Sinha*** (dps@uoregon.edu). *Cohomology rings of symmetric groups.*

We present the cohomology rings of symmetric groups, relying heavily on a Hopf ring structure on their direct sum. We start with the mod-two calculation, then move to the two-local calculation, and then give progress at general primes. Two main ingredients throughout are the geometrically defined Fox-Neuwirth cell complex and the algebraic notion of a divided-powers Hopf ring. (Received December 13, 2011)

57 ► *Manifolds and cell complexes*

1078-57-39 **Yong Seung Cho*** (yescho@ewha.ac.kr), Division of Mathematical and Physical Science, College of Natural Sciences, Ewha Womans University, Seoul, 120-750, South Korea. *Gromov-Witten invariants of symmetric products.*

Gromov-Witten Invariants of Symmetric Products

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ABSTRACT:

In this talk we want to introduce Gromov-Witten invariants of the symmetric products of symplectic manifolds and their related properties. For these we investigate the moduli spaces of equivalence classes of stable J-holomorphic rational maps representing 2-dimensional homology classes in product spaces and symmetric products, and Gromov-Witten invariants and relative Gromov-Witten invariants on them. Also we want to relate the Gromov-Witten invariants and the quantum cohomologies of symmetric products with the symmetric invariant ones of product spaces. As an example we examine the symmetric product of the complex projective line, and compute a generating series of Gromov-Witten invariants for symmetric products. (Received November 06, 2011)

1078-57-55 **Takashi Nishimura*** (nishimura-takashi-yx@ynu.jp), Research Group of Mathematical Sciences, Yokohama National University, Yokohama, 240-8501, Japan. *Whitney umbrellas and swallowtails.*

We introduce map germs of pedal unfolding type and the notion of normalized Legendrian map-germs. We show that the fundamental theorem of calculus provides a natural one to one correspondence between Whitney umbrellas of pedal unfolding type and normalized swallowtails. (Received November 13, 2011)

- 1078-57-94 **Akio Kawauchi*** (kawauchi@sci.osaka-cu.ac.jp), 3-3-138 Sugimoto-cho, Sumiyoshi-ku, Osaka, Osaka 558-8585, Japan. *Topology of prion proteins*. Preliminary report.
- The content of this talk is a joint work with Kayo Yoshida. A topological model of prion proteins (PrP^C , PrP^{SC}) which we call a prion-tangle is proposed to explain some entangling properties of prion proteins by a knot theoretical approach. We can explain in our model how two splitted prion-tangles are changed into a non-split prion-tangle with the given prion-tangles contained by a one-crossing change. We also determine for every $n > 1$ that the minimal crossing number of n -string non-split prion-tangles is $2n$ or $2n - 2$, respectively, according to whether or not we count the assumption that the loop system is a trivial link. (Received November 23, 2011)
- 1078-57-122 **Taizo Kanenobu*** (kanenobu@sci.osaka-cu.ac.jp), 3-3-138, Sugimoto, Sumiyoshi-Ku, Osaka, 558-8585, Japan. *Band surgery on knots with applications to other local moves*. Preliminary report.
- A band surgery is a local move of a knot by doing a surgery along an added band. We consider several applications of a band surgery to other local moves such as $H(n)$ -moves and $SH(n)$ -moves introduced by Hoste, Nakanishi and Taniyama. (Received November 30, 2011)
- 1078-57-155 **Takahiro Yamamoto*** (yama.t@ip.kyusan-u.ac.jp), 3-1 Matsukadai 2-chome, Higashiku, Fukuoka, 813-8503, Japan. *Topology of the singular value sets of stable maps between surfaces*. Preliminary report.
- In this talk, all maps and manifolds are class of C^∞ . Let M and N be connected, orientable and closed surfaces, and $f: M \rightarrow N$ be a stable map in Whitney's sense. Then, locally f has fold and cusp singularities and globally the singular value set $f(S(f))$ is curves with isolated cusps and nodes. For a stable map $f: M \rightarrow N$, denote by $c(f)$ and $n(f)$ the numbers of cusps and nodes of the singular value set $f(S(f))$ respectively. We determine the minimal number $c + n$ among the singular value set of degree d stable maps $M \rightarrow N$ whose contours consist of one component. (Received December 05, 2011)
- 1078-57-183 **Kenneth C Millett*** (millett@math.ucsb.edu), Department of Mathematics, UCSB, Santa Barbara, CA 93106. *Some Geometric and Topological Properties of Open Polygonal Chains*.
- Properties of open polygonal chains that depend upon geometry or topology and that are based on either rigorous proofs or numerical studies will be discussed. These include the presence and scale of entanglements such as knots and slipknots. (Received December 06, 2011)
- 1078-57-185 **Noam Goldberg** and **Thomas W. Mattman*** (TMattman@CSUCHico.edu), Department of Math, CSU, Chico, Chico, CA 95926, and **Ramin Naimi**. *Many, many more intrinsically knotted graphs*.
- We list more than 200 new examples of minor minimal intrinsically knotted graphs and describe many more that are intrinsically knotted and likely minor minimal. (Received December 06, 2011)
- 1078-57-193 **Koya Shimokawa*** (kshimoka@rimath.saitama-u.ac.jp). *On shortest pathways of unlinking by XerCD-diff-FtsK*.
- In 2007, Grainge et al. showed that, when coupled with FtsK, the site-specific recombinases XerC/XerD can unlink DNA catenanes and proposed a stepwise model of unlinking. In the previous work, we showed that their model is the only pathway from the 2m-cat to the unlink when we assume each recombination event reduces the crossing number. Here we characterize shortest pathways from the 6-cat to the unlink under the assumption that the crossing number does not increase at each event. (Received December 07, 2011)
- 1078-57-207 **Ryan D Budney*** (rybu@uvic.ca), University of Victoria, Department of Mathematics and Statistics, PO BOX 3060 STN CSC, Victoria, BC V8W 3R4, Canada, and **Benjamin Burton** and **Jonathan Hillman**. *Some simple triangulations*.
- I'll describe the story of how Thurston observed some very simple triangulations of knot and link complements in the 3-sphere. This allowed for a relatively simple way to find hyperbolic structures on such manifolds, and was a key inspiration for the Geometrization Conjecture for 3-manifolds. Ben Burton and I have recently been studying 4-dimensional triangulations and we came across an analogous triangulation for the complement of an embedded 2-sphere in the 4-sphere. While this does not lead to an amazing conjecture like Geometrization, it does lead to an interesting insight into things called Cappell-Shaneson knots, which are historically related to the smooth 4-dimensional Poincare conjecture. This is joint work with Ben Burton and Jonathan Hillman. (Received December 07, 2011)

1078-57-208 **Qayum Khan*** (qkhan@nd.edu), 255 Hurley Hall, Notre Dame, IN 46556, and **James F. Davis** and **Francis X. Connolly**. *On isovariant rigidity of CAT(0) manifolds.*

We discuss Quinn's equivariant generalization of the Borel Conjecture. This concerns cocompact proper actions of a discrete group Γ on a Hadamard manifold X . We give a complete solution when the action of Γ is pseudo-free and when X more generally is a CAT(0) manifold. Here, *pseudo-free* means that the singular set is discrete. A rich class of examples is obtained from crystallographic groups Γ made out of isometric spherical space form groups G .

If Γ has no elements of order two, then we obtain equivariant topological rigidity of the pair (X, Γ) . Hence, if Γ is torsion-free, this reduces to a recent theorem of A. Bartels and W. Lück, which validates the classical Borel Conjecture for CAT(0) fundamental groups. Otherwise, if Γ has elements of order two, we show how to parameterize all possible counter-examples, in terms of Cappell's UNil summands of the L -theory of infinite dihedral groups. In certain cases, these are detected along hypersurfaces in the orbifold X/Γ by generalized Arf invariants. (Received December 07, 2011)

1078-57-218 **Mikiya Masuda*** (masuda@sci.osaka-cu.ac.jp), Department of Mathematics, Osaka City University, 3-3-138, Sugimoto, Sumiyoshi-ku, Osaka, Japan. *Iterated circle bundles.*

An iterated circle bundle over a point is a sequence of (not necessarily principal) S^1 -bundles starting with a point:

$$M_n \xrightarrow{p_n} M_{n-1} \xrightarrow{p_{n-1}} \cdots \xrightarrow{p_2} M_1 \xrightarrow{p_1} M_0 = \{\text{a point}\}.$$

Needless to say, M_1 is a circle and M_2 is a torus or a Klein bottle. This simple construction provides many interesting examples of aspherical manifolds. In this talk, I will discuss the topology of those manifolds. It turns out that they are infra-nilmanifolds (i.e. some finite covering space is a nilmanifold) and some of them are flat Riemannian manifolds. (Received December 08, 2011)

1078-57-300 **Yuanan Diao***, Department of Mathematics, UNC Charlotte, 9201 University City Blvd, Charlotte, NC, and **Gabor Heteyi**. *Relative Tutte polynomials of tensor products of colored graphs.* Preliminary report.

The tensor product operation associates a pair of graphs (G_1, G_2) to a graph $G_1 \otimes G_2$, which is obtained by replacing each edge of G_1 with a copy of G_2 . The Tutte polynomial of such a tensor product of graphs is shown (by Brylawski) to be obtainable from the Tutte polynomials of G_1 and G_2 through some variable substitutions. This has been shown that Brylawski's formula can be extended to the case where G_1 and G_2 are colored graphs and the tensor product is generalized in such a way that only some edges in G_1 (marked by a certain color λ) need to be replaced by copies G_2 . Motivated by graphs arising from the virtual knot theory, we have recently introduced a generalized Tutte polynomial (called a relative Tutte polynomial) for graphs with colored edges and a special kind of edges (called zero edges) that cannot be treated as the regular colored edges in the computation of the Tutte polynomial. We generalize the tensor product formula for colored graphs to the relative Tutte polynomial for colored relative graphs. This generalization is highly nontrivial and is only similar to the previously known formulas in spirit. The rules of substitutions are also more complicated due to the complexity of the relative Tutte polynomial. (Received December 12, 2011)

1078-57-306 **Y. Diao**, Department of Mathematics and Statistics, University of North Carolina at Charlotte, Charlotte, NC 28223, **C. Ernst***, Department of Mathematics and Comp. Science, Western Kentucky University, Bowling Green, KY 42101, **A. Montemayor**, Department of Mathematics and Comp. Science, Western Kentucky University, Bowling Green, KY 42101, and **U. Ziegler**, Department of Mathematics and Comp. Science, Western Kentucky University, Bowling Green, KY 42101. *Generating random walks and polygons in spherical confinement.*

We discuss algorithms or methods to generate confined equilateral random walks and polygons in spherical confinement. These algorithms result in different vertex distributions inside the confinement sphere. We discuss these vertex distributions and pros and cons of the various algorithms. (Received December 12, 2011)

1078-57-316 **Christopher Allday*** (chris@math.hawaii.edu), **Matthias Franz** and **Volker Puppe**. *Equivariant Poincaré - Alexander - Lefschetz duality, results of Duflot and the homology of the Atiyah - Bredon complex.*

We calculate the homology of a cochain complex associated with the orbit filtration of a torus action on a manifold. This is done using equivariant Poincaré - Alexander - Lefschetz duality and some results of Duflot for which we give new proofs. (Received December 12, 2011)

1078-57-332 **Hwa Jeong Lee** and **Gyo Taek Jin*** (trefoil@kaist.ac.kr), Department of Mathematical Sciences, KAIST, 291 Daehak-ro Yuseong-gu, Daejeon, 305-701, South Korea. *Arc index of pretzel knots of type $(-p, q, r)$.*

We computed the arc index for some pretzel knots $K = P(-p, q, r)$ with $p, q, r \geq 2$, $q \leq r$, and at most one of p, q, r is even. If $q = 2$, then the arc index $\alpha(K)$ equals the minimal crossing number $c(K)$. If $p \geq 3$ and $q = 3$, then $\alpha(K) = c(K) - 1$. If $p \geq 5$ and $q = 4$, then $\alpha(K) = c(K) - 2$. (Received December 12, 2011)

1078-57-356 **Eric J Rawdon*** (ejrawdon@stthomas.edu). *Knotted open chains*. Preliminary report.

Some proteins are now classified as being knotted. However, proteins have free ends and knotting, traditionally, has only been defined formally for closed curves. Defining knotting in open chains is tricky and ambiguous. We will show one definition of open knotting and search for minimal length knotted arcs within knotted open and closed chains. This is joint work with Ken Millett, Andrzej Stasiak, and Joanna Sulowska. (Received December 13, 2011)

58 ► *Global analysis, analysis on manifolds*

1078-58-16 **Markus J Pflaum*** (markus.pflaum@colorado.edu), Department of Mathematics, University of Colorado UCB 395, Boulder, CO 80305, and **Hessel Posthuma** and **Xiang Tang**. *Geometry of orbit spaces of proper lie groupoids*.

We study geometric properties of quotient spaces of proper Lie groupoids. It is shown how one can construct a natural stratification of such orbit spaces by using an extension of the slice theorem for proper Lie groupoids of Weinstein and Zung. Next, the existence of an appropriate metric on the groupoid giving the associated Lie algebroid the structure of a singular riemannian foliation is shown. With this metric, the orbit space inherits a natural length space structure. Moreover, we prove that the orbit space of a proper Lie groupoid can be triangulated. Finally, we derive a de Rham theorem for the complex of basic differential forms on a proper Lie groupoid. (Received September 20, 2011)

1078-58-59 **James N. Damon*** (jndamon@math.unc.edu), Department of Mathematics, University of North Carolina, Phillips Hall CB 3250, Chapel Hill, NC 27599. *Singularity theory for mappings on special semi-analytic stratifications*.

This talk describes joint work with Peter Giblin on a problem which arises in computer imaging, when images involve geometric features of objects, shade/shadow from a light source, and viewer direction and movement.

A straightforward approach would require the application of singularity theory to two projections from certain stratified spaces representing the geometric features. This involves the problem of divergent diagrams. Although Dufour was able to classify the stable germs of divergent diagrams on smooth spaces in several special cases, the general results of singularity theory do not apply because of the absence of a version of the Malgrange preparation theorem.

We overcome this problem by identifying the general types of stratifications arising from one projection and reducing to the application of singularity theory to smooth mappings on a class of “special semianalytic stratifications”. The singularity theory provides all of the necessary results including results on topological versality. Then, a further problem is solved on which mappings and their deformations from the abstract classifications have geometric realizations for the projections. (Received November 15, 2011)

1078-58-74 **Goo Ishikawa*** (ishikawa@math.sci.hokudai.ac.jp), Dep. of Math., Hokkaido Univ., Kita 10 Nishi 8, Kitaku, Sapporo., 060-0810, Japan. *Openings of stable unfoldings*.

For a map-germ $f : \mathbf{K}^n \rightarrow \mathbf{K}^m$, ($n \leq m$, $\mathbf{K} = \mathbf{R}$ or \mathbf{C}), we introduce the notion of *openings* of f . An opening $F : \mathbf{K}^n \rightarrow \mathbf{K}^m \times \mathbf{K}^r$ of f , separates, via the projection $\pi_1 : \mathbf{K}^m \times \mathbf{K}^r \rightarrow \mathbf{K}^m$, the self-intersections of the original f , preserving the singularities of f . The notion of openings of f is different from the notion of unfoldings $\mathbf{K}^n \times \mathbf{K}^k \rightarrow \mathbf{K}^m \times \mathbf{K}^k$: Openings do not unfold the singularities. For example, the swallowtail is an opening of Whitney’s cusp $\mathbf{K}^2 \rightarrow \mathbf{K}^2$ and the open swallowtail is a “versal” opening of them. Openings of map-germs appear as typical singularities in several problems of geometry and its applications. The notion of openings has close relation to isotropic map-germs in a symplectic space and integral map-germs in a contact space. We will describe the openings of Morin singularities, namely, stable unfoldings of map-germs of corank 1. Moreover we will show the method to construct versal openings of map-germs of corank ≥ 2 . (Received November 21, 2011)

- 1078-58-162 **M. Pflaum** and **H. Posthuma** (xtang@math.wustl.edu), 63130, and **X. Tang*** (xtang@math.wustl.edu), Department of Mathematics, Washington University, St. Louis, MO 63130. *The localized Longitudinal index theorem for Lie groupoids and the Van Est map.*

We define the “localized index” of longitudinal elliptic operators on Lie groupoids associated to Lie algebroid cohomology classes. We derive a topological expression for these numbers using the algebraic index theorem for Poisson manifolds on the dual of the Lie algebroid. Underlying the definition and computation of the localized index, is an action of the Hopf algebroid of jets around the unit space, and the characteristic map it induces on Lie algebroid cohomology. This map can be globalized to differentiable groupoid cohomology, giving a definition as well as a computation of the “global index”. The correspondence between the “global” and “localized” index is given by the van Est map for Lie groupoids. (Received December 05, 2011)

- 1078-58-175 **Masatomo Takahashi*** (masatomo@mmm.muroran-it.ac.jp), Mizumotocho 27-1, Muroran, Hokkaido 050-8585, Japan. *Singularities of smooth mappings with patterns.*

The smooth mappings with patterns which given by certain divergence diagrams of smooth mappings can be regarded as smooth mappings from manifolds with singular foliations. Our concerns are generic differential topology and generic smooth mappings with patterns. We give a generic semi-local classifications of a special class of smooth mappings with patterns as an applications of singularity theory. (Received December 06, 2011)

- 1078-58-261 **Bo Guan***, Department of Mathematics, Ohio State University, Columbus, OH 43210, and **Qun Li**. *Some fully nonlinear Monge-Ampere type equations on Hermitian manifolds.*

We'll present some recent results on a class of fully nonlinear equations of Monge-Ampere type on compact Hermitian manifolds. (Received December 11, 2011)

- 1078-58-348 **Massimo Ferrarotti**, **Elisabetta Fortuna** and **Leslie Charles Wilson*** (les@math.hawaii.edu), University of Hawaii, Department of Mathematics, 2565 McCarthy Mall, Honolulu, HI 96822. *Algebraic approximation of semianalytic sets.* Preliminary report.

Two sets A and B are said to be s -equivalent at x if $H(A \cap S_r, B \cap S_r) = o(r^s)$, where S_r is the sphere of radius r centered at x , and H is the Hausdorff distance. We prove that a semianalytic set is, for each x and each s , s -equivalent to some algebraic variety at x . (Received December 13, 2011)

60 ► Probability theory and stochastic processes

- 1078-60-111 **Stephane P Jaffard*** (jaffard@u-pec.fr), LAMA, Faculte des Sciences, Université Paris-Est Creteil Val de Marne, 61 avenue du Général de Gaulle, 94010 Creteil, France. *Multifractal analysis for art investigation.*

In image processing, texture analysis is a both common and important issue. Unlike traditional fractal techniques, which usually associate one parameter to analyzed data (a fractal dimension) in order to perform their classification, multifractal analysis associates a whole function to the analyzed data: Their multifractal spectrum. This spectrum encapsulates the dimensions of all singularity sets of different intensities present in the data. We will be explain in what sense multifractal analysis is related with the scale invariance properties of the texture, and how wavelet decomposition techniques give access to a dual quantity, the “scaling function”. The potential, benefits and limitations of multifractal analysis for art investigations will be illustrated on three different data sets: - A collection of originals and replicas, painted by the same artist, as a scientific experience and testbed (the Princeton experiment) - Paintings by Van Gogh and contemporaries, with challenges in terms of dating Van Gogh's paintings or discriminating Van Gogh's from non Van Gogh's - Drawings by Brueghel, with challenge in terms of discriminating originals from imitations. This is a joint work with P. Abry (ENS Lyon) and H. Wendt (Purdue University). (Received November 29, 2011)

- 1078-60-159 **Frederik Herzberg***, Bielefeld University, Institute of Mathematical Economics, Universitaetsstrasse 25, D-40215 Bielefeld, Germany. *Towards ‘radically elementary’ stochastic analysis.*

In his monograph *Radically Elementary Probability Theory* [Annals of Mathematics Studies, vol. 117 (1987)], Edward Nelson has laid the foundations of a theory of continuous-time stochastic processes that is accessible to “anyone who can add, multiply, and reason”. This talk will summarize ongoing research which, on the basis of Nelson's work, develops a ‘radically elementary’ approach to stochastic analysis and its manifold applications, especially in financial mathematics and quantum mechanics. (Received December 05, 2011)

1078-60-196 **Tom Lindstrøm*** (lindstro@math.uio.no), Department of Mathematics, University of Oslo, Box 1053 Blindern, N-0316 Oslo, Norway. *Stochastic analysis on hyperfinite products of hyperfinite spaces.*

In his 1984 AMS Memoir "An infinitesimal approach to stochastic analysis", H. J. Keisler showed how the theory of diffusion processes can be based on hyperfinite products of the simplest probability spaces conceivable, i.e. those with only two elements. It has since been shown that in theory Keisler's space are sufficiently rich to carry all kinds of probabilistic behavior, but in practice it often more convenient to use spaces tailored to the phenomenon one wants to model; if, e.g., one wants to model stochastic processes with jumps, it is an advantage to use models where the atoms reflect the size and frequency of the jumps.

In this talk, I shall look at stochastic analysis and Malliavin calculus on more general products of hyperfinite probability spaces. (Received December 07, 2011)

1078-60-304 **Derek Lougee** and **Benjamin Steinhurst***, steinhurst@math.cornell.edu. *Percolation on Non-p.c.f. Sierpinski gaskets and hexacarpet.*

We discuss bond percolation on the a non-post critically finite analogue to the usual Sierpinski carpet and show that critical probability to percolate across the fractal is strictly less than one. Then using a modified dual graph argument we show that it is strictly greater than zero giving a non-trivial phase transition. The dual graph that arises is the hexacarpet which has recently been taken up as an interesting example. Our methods give a non-trivial phase transition on the hexacarpet as simple corollary to the main argument. (Received December 12, 2011)

65 ► Numerical analysis

1078-65-182 **Michael McCourt*** (mccomic@mcs.anl.gov), 10 W. 32nd St., Rm. 208, Chicago, IL 60616, and **Greg Fasshauer** (fasshauer@iit.edu), 10 W. 32nd St., Rm. 208, Chicago, IL 60616. *Stable Computations with Gaussians.*

The practical application of kernels is often impeded by ill-conditioning present for certain choices of RBF. The most common choice in some communities, the Gaussian, is optimal for approximating sufficiently smooth functions; it is also the most susceptible to conditioning issues and thus the least trustworthy in many circumstances. This work provides a new way to compute and evaluate Gaussian RBF interpolants in a stable way in arbitrary dimensions with a focus on increasingly flat kernels. Motivated by the pioneering research of Bengt Fornberg and his co-workers, an eigenfunction (or Hilbert-Schmidt) expansion of the Gaussian is used to isolate ill-conditioned terms analytically. In addition to obtaining the true RBF interpolant, this technique can also be used to produce a highly accurate least-squares approximation at significantly less cost. Interpolation and regression results will be presented, as well as collocation results for boundary value problems. (Received December 06, 2011)

1078-65-194 **Weitao Chen**, **Ching-Shan Chou** and **Chiu-Yen Kao*** (kao@math.ohio-state.edu). *Fast Sweeping Methods for Steady State Problems of Hyperbolic Conservation Laws with Source Terms.*

We propose several simple fast sweeping methods to approximate the steady state solutions of hyperbolic conservation laws with source terms. The original fast sweeping methods were developed for stationary Hamilton-Jacobi equations. The methods replies on numerical Hamiltonian, Gauss-Seidel type nonlinear iterative method, and a finite number of sweeping directions to compute the stationary viscosity solution efficiently. We extend the fast sweeping methods to solve hyperbolic conservation laws with source terms. By incorporating the numerical flux and relaxation of iterative scheme, we developed efficient methods which can capture correct stationary viscosity solutions even when discontinuities appear. Extensive numerical examples in both scalar and system of equations in one and two dimensions illustrate the efficiency and accuracy of the new approaches. (Received December 07, 2011)

1078-65-214 **Sheehan Olver*** (Sheehan.Olver@sydney.edu.au), School of Mathematics and Statistics, The University of Sydney, Sydney, NSW 2006, Australia, and **Thomas Trogdon** (trogdon@amath.washington.edu), Department of Applied Mathematics, University of Washington, Box 352420, Seattle, WA 98195-2420. *Numerical inverse scattering for KdV and NLS.*

We develop a framework for utilizing inverse scattering theory to numerically solve integrable systems, including the Korteweg-de Vries equation and the focussing and defocussing nonlinear Schrödinger equations. We employ straightforward spectral methods to compute the forward transform. By using a recently developed method for

solving Riemann–Hilbert problems, we can successfully compute the inverse transform as well. Deforming the Riemann–Hilbert problems appropriately results in a numerical method which remains accurate for all space and time, unimpaired by the high oscillations present in the solutions. (Received December 08, 2011)

1078-65-215 **Thomas Trogdon*** (trogdon@amath.washington.edu), **Sheehan Olver** (sheehan.olver@sydney.edu.au) and **Bernard Deconinck** (bernard@amath.washington.edu). *Uniform numerical approximation of integrable equations via Riemann–Hilbert problems.*

The Riemann–Hilbert formulations of the Korteweg–de Vries and the Painlevé II transcendent have proved to be computationally valuable. Borrowing ideas from the method of nonlinear steepest descent, the resulting numerical schemes are seen to be asymptotically reliable. Here we derive some sufficient conditions for a numerical method to maintain accuracy throughout unbounded regions of the plane on which the differential equation is posed. (Received December 08, 2011)

1078-65-249 **Stefano De Marchi*** (demarchi@math.unipd.it), Via Trieste, 63, 35121 Padova, Italy, and **Amos Sironi**. *A kernel based method for medical image reconstruction.* Preliminary report.

The image reconstruction problem consists in finding an approximation of a function f starting from its Radon transform.

This problem arises in the framework of medical imaging when one wants to reconstruct the internal structure of a sample starting from its X-rays tomography.

Classical reconstruction methods are based on the *back projection formula*.

In this paper we propose an alternative approach that uses positive de finite kernel functions and that can be applied also in presence of scattered data. We approximate the function f using Hermite–Birkhoff interpolation, introducing a regularization technique that is needed when the Radon transform of a kernel basis function is in finity. (Received December 10, 2011)

1078-65-256 **Rodrigo B Platte*** (rbp@asu.edu), Arizona State University, P.O. Box 871804, Tempe, AZ 85287-1804, and **Jordan Martel**. *Stability of kernel methods for time-dependent partial differential equations on the circle and sphere.*

Conditions for stability of collocation methods based on radially symmetric kernels for time-dependent problems on the circle and sphere are presented. Of particular interest is the advection equation with variable coefficients. We show that on equally spaced nodes, discretization matrices of the convection operator have purely imaginary eigenvalues. Lax-stability for problems on the sphere when the collocation points come from certain polyhedra is also discussed. In both geometries, we demonstrate that spurious eigenvalues of discretization matrices grow almost linearly with perturbations off the set of ideal collocation points. (Received December 11, 2011)

1078-65-352 **Elisabeth Larsson*** (Elisabeth.Larsson@it.uu.se), Uppsala University, Dept. of Information technology, Box 337, SE-751 05 Uppsala, Sweden, and **Alfa Heryudono**. *A partition of unity radial basis function collocation method for partial differential equations.*

For partial differential equations with smooth solutions, radial basis function approximation methods are attractive due to the potentially spectral convergence rates. However, in practice, the success is hampered by ill-conditioning as the problem size grows and as the kernels are made flatter. Furthermore, the computational cost when direct solution methods are used for the arising full linear systems is prohibitive for large-scale problems.

We propose a partition of unity approach where radial basis function approximation is employed within each partition. The introduced locality reduces both memory usage and computational cost compared with the global method. However, in order to achieve numerical convergence, we also need stable evaluation of the approximants for nearly flat kernels. This is achieved through employment of the recently developed RBF-QR algorithm (Fornberg, Larsson, Flyer 2011).

We provide numerical experiments showing spectral convergence with respect to the local problem resolution and algebraic convergence with respect to the partition size. We also discuss how far these results are supported by theory and what the important restrictions are. Furthermore, we discuss how these techniques perform for problems formulated on manifolds. (Received December 13, 2011)

1078-65-394 **Grady B Wright*** (gradywright@boisestate.edu) and **Edward J Fuselier**. *Solving partial differential equations on surface with kernels.* Preliminary report.

Kernel methods such as those based on radial basis functions (RBFs) are becoming increasingly popular for numerically solving partial differential equations (PDEs) because they are geometrically flexible, algorithmically

accessible, and can be highly accurate. There have been many successful applications of this technique to various types of PDEs defined on planar regions in two and higher dimensions, and more recently to PDEs defined on the surface of a sphere. In this talk we describe the first kernel method based on RBFs for numerically solving parabolic PDEs defined on more general surfaces, specifically on smooth, closed embedded submanifolds. Applications of this method to certain biologically relevant, non-linear reaction diffusion equations will be presented on various surfaces. (Received December 13, 2011)

68 ► Computer science

1078-68-66 **Catherine Walker*** (walkercl@hawaii.edu), **J. B. Nation** and **Hye Jung Kim**. *Complex reflection group coding*.

Coding schemes for group codes based on some exceptional complex reflection groups will be introduced and analyzed using the classification of finite reflection groups by Shephard and Todd. The implications of the group structure for coding will be discussed. (Received November 17, 2011)

1078-68-327 **J. B. Nation*** (jb@math.hawaii.edu), Department of Mathematics, University of Hawaii, Honolulu, HI 96822. *Partial group codes*.

If H is a finite subset of a (possibly infinite) unitary group G on \mathbb{C}^n , and $x_0 \in \mathbb{C}^n$, then we can form the code $Hx_0 = \{hx_0 : h \in H\}$. By choosing H carefully, we can construct some interesting codes with desirable properties. (Received December 12, 2011)

76 ► Fluid mechanics

1078-76-65 **Chunqing Lu*** (clu@siue.edu), Department of Mathematics and Statistics, Southern Illinois University Edwardsville, Edwardsville, IL 62026. *Bifurcation of Solutions to a Boundary Layer Problem*. Preliminary report.

Consider that a plate is semi-infinite with a porous surface and moves at a constant speed U_w in the direction parallel to a uniform stream flow. Assume the stream flow has a constant speed U_∞ , and that the same fluid is being injected or sucked. Then the generated laminar flow satisfies one of the Navier-Stokes equations: $U \frac{\partial U}{\partial X} + V \frac{\partial V}{\partial Y} = \frac{1}{\rho} \frac{\partial \tau_{XY}}{\partial Y}$. Set the shear stress $\tau_{XY} = K \left| \frac{\partial U}{\partial Y} \right|^{N-1} \frac{\partial U}{\partial Y}$ where $K > 0$ and $N \in (0, 1]$ are constant. Introducing a stream function and a similarity variable, we transform the above partial differential equation into an o.d.e

$$\left(|f''(\eta)|^{N-1} f''(\eta) \right)' + f(\eta) f''(\eta) = 0,$$

subject to boundary conditions

$$f(0) = -C, f'(0) = \xi, f'(+\infty) = 1,$$

where $\xi = \frac{U_w}{U_\infty}$, $C = \frac{BV_0(N+1)}{U_\infty}$ for a constant V_0 . This paper proves a new sufficient condition for the existence of multiple solutions to the boundary value problem. It does not require the lower boundedness of ξ , which is simpler and different from the known results. (Received November 17, 2011)

1078-76-264 **James P Kelliher*** (kelliher@math.ucr.edu), **Milton C Lopes Filho** and **Helena J Nussenzveig Lopes**. *Bounded vorticity, bounded velocity (Serfati) solutions to 2D Euler equations in an external domain*.

In a short note in 1995, Philippe Serfati established the existence and uniqueness of solutions to the 2D Euler equations in the whole plane when the initial vorticity and initial velocity are bounded. We describe an extension of this result to an external domain in the plane, and discuss related issues of stability. (Received December 11, 2011)

1078-76-275 **Jon Wilkening*** (wilken@math.berkeley.edu), Department of Mathematics, University of California, Berkeley, CA 94720-3840. *Elastic solitary water wave interactions*.

Multiple soliton solutions of integrable equations such as the Korteweg-deVries equation, the Benjamin-Ono equation, and the Nonlinear Schrödinger equation often feature elastic collisions. By contrast, the interaction of solitary Stokes waves for the Euler equations is inelastic. However, it has been observed many times in the literature that the residual radiation after a collision of Stokes waves can be remarkably small. I will show how to tune the background radiation to support solitary wave interactions that do not generate additional radiation after a collision. This is done by computing spatially and temporally periodic solutions of the full Euler equations in two solitonic regimes using high resolution numerical simulations. In shallow water with no surface tension,

we find counter-propagating KdV-like “solitons” that collide elastically. In deep water with surface tension, we find elastic collisions of NLS-like solitons. A Floquet analysis shows that some of the solutions in each regime are stable to harmonic perturbations. (Received December 12, 2011)

1078-76-372 **Elizabeth Thoren*** (ethoren@math.ucsb.edu). *Linear instability for Euler’s equation - Two classes of perturbations.*

In this talk we will consider 2- and 3-dimensional Euler’s equation linearized at steady-state solutions and examine the growth of high frequency perturbations in two separate classes: those that preserve circulation and the corresponding factor space. Instability criteria for each type of perturbation will be established in the form of lower bounds for the essential spectral radius of the linear evolution operator restricted to each class. (Received December 13, 2011)

82 ► *Statistical mechanics, structure of matter*

1078-82-96 **Jiro Suzuki***, Oho, Tsukuba, Ibaraki 305-0801, Japan, **Atsushi Takano**, Furo-cho Chikusa, Nagoya, Aichi 464-8603, Japan, and **Yushu Matsushita**, Furo-cho Chikusa, Nagoya, Aichi 464-8603, Japan. *Theta-temperature depression caused by topological effect in ring polymers.*

We studied equilibrium conformations of linear and trivial-ring polymers in dilute solutions over the wide range of segment number N of up to 2048 with Monte-Carlo simulation, and N dependence of the radii of gyration, R_g , of chains were obtained. The polymer molecules were assumed to be composed of beads and bonds, and they were put in a face-centered cubic (FCC) lattice. The values of Flory’s critical exponent, ν , for linear and trivial-ring polymers were estimated from the N dependence of R_g , and the temperatures at which ν values reach 1/2 were obtained. Here we define those are Θ -temperatures in this report. The simulation result shows that the Θ -temperature for trivial-ring polymers is evidently lower than that of the linear polymers. Since R_g of a trivial-ring polymer is smaller than that for a linear polymer at the same N and temperature, the segment density for a trivial-ring polymer is increased by the topological effect and the repulsive force between segments of a trivial-ring polymer at the Θ -temperature for a linear polymer is stronger. Thus, the origin of the Θ -temperature depression for trivial-ring polymers is the repulsive force emphasized by the topological effect of rings. (Received November 25, 2011)

1078-82-139 **E J Janse van Rensburg*** (rensburg@yorku.ca), EJ Janse van Rensburg, Toronto, Ontario M3J 1P#, Canada. *Knotted lattice polygons.*

Polygons in the cubic lattice are simple closed curves in three space and have well-defined knot types. The number of lattice polygons of length n and knot type K in the cubic lattice is $p_n(K)$, where we consider two polygons to be equivalent under translations in the lattice. For example, if K is the unknot \emptyset , then $p_4(\emptyset) = 3$, $p_6(\emptyset) = 22$, $p_8(\emptyset) = 207$ and so on. Determining $p_n(K)$ for arbitrary n and knot types K is a difficult numerical problem, but the GAS-algorithm implemented with BFACF-style elementary moves can be used for approximate enumeration of $p_n(K)$, and also to sieve minimal length knotted polygons. In this talk I shall present and review some entropic and other properties of minimal length lattice polygons obtained by an implementation of the GAS-algorithm in the cubic, fcc and bcc lattices.

Joint work with Andrew Rechnitzer (Received December 02, 2011)

1078-82-145 **Joe P. Chen*** (joe.p.chen@cornell.edu), Departments of Physics and Mathematics, Cornell University, Malott Hall, Ithaca, NY 14853, and **Baris E. Ugurcan** (beu4@cornell.edu), Department of Mathematics, Cornell University, Malott Hall, Ithaca, NY 14853. *Gaussian free fields on post-critically finite fractals and Sierpinski carpets.* Preliminary report.

The Gaussian free field on a bounded domain $K \subset \mathbb{R}^d$ is, roughly speaking, a standard Gaussian random variable on the Sobolev space $H^1(K)$, or a d -time-dimensional Brownian motion. Such objects, which form the building blocks of scalar quantum field theory, are well studied on Euclidean domains. In this paper we undertake the first systematic investigation of Gaussian free fields on fractals. We explicitly construct the massless and massive free fields on several representative fractals, such as the Sierpinski gasket and the Sierpinski carpet, and discuss their properties in detail. (Received December 12, 2011)

1078-82-195 **Erica Uehara**, Ochanomizu University, 2-1-1 Ohtsuka, Bunkyo-ku, Tokyo, 112-8610, Japan, and **Tetsuo Deguchi*** (deguchi@phys.ocha.ac.jp), Ochanomizu University, 2-1-1 Ohtsuka, Bunkyo-ku, Tokyo, 112-8610, Japan. *Universal curve for the distribution function of distance between two vertices with a given arc length of SAW*. Preliminary report.

Through numerical simulation we measure the distance between such a pair of vertices that are separated by an arc length λN located on an SAW for a large number of SAW with N vertices on the cubic lattice generated by the Monte Carlo method. We draw the graphs of distribution function of distance between two such vertices for many different values of λ and N . Here, fraction λ is greater than or equal to 0.3 and less than 0.9: $0.3 \leq \lambda < 0.9$. We then find out numerically the existence of a universal curve for the distribution functions of distance: The graphs for different values of N or λ completely overlap each other if we plot them in terms of the normalized distance with respect of the square root of the mean square of distance. This universal curve should be useful for studying the scaling aspects of knotted random polygons. (Received December 07, 2011)

1078-82-206 **Kyoichi Tsurusaki*** (urusaki@kanagawa-iri.go.jp), 705-1, Shimoimaizumi, Ebina, Kanagawa 243-0435, Japan. *General polygonal length dependence of the linking probability for ideal random polygons*.

We discuss the linking probability, P_{link} , that two ideal random polygons (RPs) are topologically entangled. P_{link} is a function of the distance between two RPs, R , and the polygon length, N . We have shown that the scaling behavior of P_{link} can be expressed by a simple function: $P_{\text{link}}(\xi; N) = \exp(-\kappa_1 \xi^{\mu_1}) - C \exp(-\kappa_2 \xi^{\mu_2})$, where ξ is the ratio of R to the radius of gyration R_g : $\xi = R/R_g$. The values of κ_1 , μ_1 , κ_2 , μ_2 and C have been numerically evaluated for RPs with discrete values of N from 32 to 512. Considering physical requirements of P_{link} in two limits of $N \rightarrow 0$ and $N \rightarrow \infty$, we can derive six constraints between these parameters. By taking account of both the numerical data and the constraints, we propose function forms of $\kappa_1(N)$, $\mu_1(N)$, $\kappa_2(N)$, $\mu_2(N)$ and $C(N)$. As a consequence, we can calculate P_{link} for not only a finite value of N but also $N \rightarrow \infty$. We also introduce an application of this result to the ring polymer system. (Received December 07, 2011)

1078-82-368 **Chris Soteros*** (soteros@math.usask.ca). *Knot reduction for a lattice polygon model of local strand passage*. Preliminary report.

From DNA experiments, it is known that type II topoisomerases can reduce the fraction of knots in DNA over that found in randomly cyclized DNA; the amount that the fraction of knots is reduced is one measure of “knot reduction”. These topoisomerases act locally in the DNA by transiently breaking one strand of DNA to allow another strand to pass through (strand passage). Szafron and Soteros have used a self-avoiding polygon model on the simple cubic lattice to model this strand passage action. The details of the combinatorial and topological theory behind this model will be reviewed. Also our Monte Carlo results on how knot reduction depends on the local juxtaposition structure at the strand passage site will be reviewed. We have found correlations between knot reduction and the crossing-sign and crossing-angle at the strand passage site. Preliminary results on the effect of varying solvent quality and/or the strand passage structure on knot reduction will also be presented. (Received December 13, 2011)

1078-82-412 **Satoshi Tanda*** (tanda@eng.hokudai.ac.jp), Sapporo, Hokkaido 060-8628, Japan. *Topological crystals as a new paradigm*.

We report the discovery of Mobius, Ring, Figure-8, Hopf-link Crystals in NbSe₃, conventionally grown as ribbons and whiskers. We also reveal their formation mechanisms of which two crucial components are the spherical selenium (Se) droplet, which a NbSe₃ ber wraps around due to surface tension, and the monoclinic (P2(1)/m) crystal symmetry inherent in NbSe₃, which induces a twist in the strip when bent. Our crystals provide a non-ctitious topological Mobius world governed by a non-trivial real-space topology. We classified these topological crystals as an intermediary between condensed matter physics and mathematics.

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92 ► *Biology and other natural sciences*

1078-92-184 **Daniel J. Catanese, Jonathan M. Fogg, Milenka Arevalo-Soliz, Erol Bakkalbasi, Truston J. Bodine, Donald E. Schrock, Brian E. Gilbert and Lynn Zechiedrich*** (elz@bcm.edu), Molecular Virology & Microbiology, One Baylor Plaza, Mail-stop: BCM-280, Houston, TX 77025. *Advances in using Supercoiled Minivector DNA for Gene Therapy*. Preliminary report.

Gene therapy requires delivering nucleic acids to diseased organs and cells. We have developed nonviral gene therapy vectors called Minivectors. Using a site-specific intramolecular recombination reaction allows for milligram production of closed circular, supercoiled DNAs as small as 250 bp. We have published that Minivectors (i) transfect human cells; (ii) express genes, shRNAs, or miRNAs; and (iii) resist shear forces associated with vector delivery and human serum nucleases.

To track Minivectors in cells or live animals, we developed a protocol for site-specific labeling of supercoiled Minivectors. We attach any chemical moiety (e.g., fluorescent dyes) to a specific nucleotide within a given sequence. To evaluate the potential of intravenous delivery of Minivectors into humans, we subjected supercoiled DNAs of varying lengths to human serum. DNA degradation strongly correlated with DNA length and was independent of DNA sequence.

Funded by the National Institutes of Health (NIH), the Human Frontier Science Program, and the Seattle's Children's Hospital Research Foundation, which is funded by the NIH. (Received December 06, 2011)

1078-92-253 **Janpou Nee*** (jpnnee@ctu.edu.tw), General Education Center, ChienKuo Technology University, Cheng-Hua, Taiwan, Taiwan, and **Hsi-Chuan Huang** (schw@cc.ctu.edu.tw), Department of Automation Engineer, and Institute of Mechatronoptic Systems, ChienKuo Technology University, Changhua, Taiwan. *On the behavior of the solutions of certain Turing system*.

The species of fungal are manifold including some precious Chinese herb. In this article we study the model discussed by F. A. Davidson et al and it is a system of parabolic equations that describe the activation and depletion. The behavior of the solutions of this biological system is complicated due to the positive cubic nonlinear reaction term which, in general, cause the solutions blow-up in finite time. However, with a suitable restriction to the diffusion coefficients there will exist a global absorbing set for any initial value. To demonstrate the results, we extend generalized maximum principle of W. M. Ni et al of elliptic equations to parabolic equation. (Received December 10, 2011)

1078-92-280 **Isabel K. Darcy*** (idarcy.math@gmail.com), Department of Mathematics, 14 MacLean Hall, Iowa City, IA 52242-1419, and **Candice Price** (candice.r.price@gmail.com), Department of Mathematics, 14 MacLean Hall, Iowa City, IA 52242-1419. *Difference topology experiments and skein relations*.

There are proteins which can knot circular DNA. The protein topoisomerase can change the knot type of circular DNA by breaking a segment of DNA, allowing a second segment to pass through the break before resealing the break. This results in a crossing change. Recombinases are another family of proteins which can knot circular DNA. Their operation is mathematically equivalent to smoothing a crossing.

A skein triple is a set of three knot diagrams which differ at exactly one crossing. In the triple, (K_+, K_-, K_0) , the knots K_+, K_- differ by a crossing change which may represent topoisomerase action. K_0 is obtained by smoothing that crossing which represents recombinase action. Both recombinases and topoisomerases have been used in an experimental technique called difference topology to probe the topological conformation of DNA bound by proteins of interest. The types of knots produced by topoisomerase and recombinase will differ depending on whether the DNA is bound by other proteins. This difference is used to solve for the shape of DNA bound by proteins of interest. The skein triple can be used to determine what is the most efficient experimental set-up for difference topology experiments. Two published experiments will be analyzed. (Received December 12, 2011)

1078-92-324 **Javier Arsuaga*** (jarsuaga@sfsu.edu), San Francisco, CA 94132, **Yuanan Diao**, University of North Carolina, Charlotte, NC, and **Kenneth Hinson**, San Francisco State University, San Francisco, CA. *The role of DNA condensation on formation of minicircle networks in trypanosomes*.

Trypanosomes are the cause of deadly diseases in many third world countries. A distinctive feature of these organisms is the three dimensional organization of their mitochondrial DNA into maxi and minicircles. In some of these organisms minicircles are coned into a small disk shaped volume and are topologically linked, forming a gigantic linked network. The origins of such a network as well as of its topological properties are mostly

unknown. In this talk we propose a new model for the formation of the DNA network based purely on the density of minicircles. We introduce a simple mathematical model in which a collection of randomly oriented minicircles are spread over a polygonal grid. We present analytical and computational results showing that a finite positive critical percolation density exists, that the probability of formation of a highly linked network increases exponentially fast when minicircles are coned, and that the mean minicircle valence (the number of minicircles that a particular minicircle is linked to) increases linearly with density. When these results are interpreted in the context of the mitochondrial DNA of the trypanosome they suggest that DNA density/confinement plays a key role on the formation of the linked network. (Received December 12, 2011)

1078-92-338 **Mariel Vazquez*** (mariel@sfsu.edu), Mathematics Department, San Francisco State University, 1600 Holloway Avenue, San Francisco, CA 94132, and **Kai Ishihara** and **Koya Shimokawa**. *DNA unknotting and unlinking by XerCD-FtsK*.

In 2007, Grainge *et al.* showed that, when coupled with FtsK, the site-specific recombinases XerC/XerD can unlink DNA catenanes and proposed a stepwise model of unlinking. We show that their model is the only pathway from the 2m-cat to the unlink when we assume that each recombination event reduces the crossing number. (Received December 12, 2011)

1078-92-406 **Joanna I Sulkowska*** (jsulkow@physics.ucsd.edu), 9500 Gilman Drive, La Jolla, CA 92037, **Jeff K Noel**, 9500 Gilman Drive, La Jolla, CA 92037, and **Jose N Onuchic**, 9500 Gilman Drive, La Jolla. *Folding mechanism of the smallest knotted protein*.

The tangling of biophysical objects such as proteins is mysterious. For example, it was long believed that proteins would not create knots since this complicates folding. Recent experiments confirmed their existence, however folding from a fully extended polypeptide has not yet been observed. Understanding the mechanism of folding knots is a current challenge for both experimental and theoretical investigation. Recently using molecular dynamics simulations with structure-based, protein models (SBM) we found that three proteins with different folds but the same topology of trefoil knot show the same folding mechanism. These studies suggest that folding the knot involves the protein terminal threading across a native-like loop, formed in a pre-ordered intermediate. During threading the terminal takes form of so called plug or slipknot motif. SBM neglect residual energetic roughness that may become important in exotic protein conformations such as threading polypeptide loops. To understand energetic advantage of slipknot motif during folding we performed detailed atomic simulations of these threading events, starting from conformations obtained from SBM. Completed threading events, both plugging and slipknotting, starting from pre-ordered intermediates were observed. (Received December 13, 2011)

94 ► *Information and communication, circuits*

1078-94-24 **Vladimir D Tonchev*** (tonchev@mtu.edu). *Combinatorial constructions of quantum codes*.

Several constructions of quantum stabilizer codes based on various types of combinatorial designs and configurations in a finite projective or affine geometry are discussed. (Received October 18, 2011)

1078-94-27 **John A Holbrook*** (jholbroo@uoguelph.ca), 50 Stone Road E, Guelph, Ontario N1G 2W1, Canada. *Error-correcting quantum codes and variations on the numerical range*.

Given the operator sum representation of a quantum channel, the Knill-Laflamme criterion for correctable code subspaces led to the study of a new type of numerical range: the so-called "higher-rank numerical range" (applied to combinations of the error operators for the channel). This talk will survey the remarkable developments in the theory of these ranges, including convexity results and the study of the statistical distribution of points within the classical numerical range. Returning to the original motivation we'll consider the extension of such results to several operators simultaneously - the "joint higher-rank numerical ranges". (Received October 30, 2011)

1078-94-52 **Hiroki Shimakura***, Department of Mathematics, Aichi University of Education, 1 Hiroasawa, Igaya-cho, Kariya, Aichi 448-8542. *Binary codes, lattices and vertex operator algebras*.

I will talk about relations among binary codes, lattices and vertex operator algebras. In particular, I will discuss the constructions of the extended binary Golay code, the Leech lattice and the moonshine vertex operator algebra by using quadratic spaces, and the automorphisms associated to the orthogonal groups. (Received November 13, 2011)

1078-94-80 **Justin Kekoa Kong*** (kongjust@hawaii.edu), 2008 Aaniu Loop, Pearl City, HI 96782. *Special permutation code weights*. Preliminary report.

In recent years permutation codes have emerged as a field of great interest with various new applications being suggested. In this paper we investigate subgroups of the symmetric group, S_n , of permutations on n elements. Our primary interest is characterizing the minimum weight and weight distribution of these subgroup cases in an effort to create a robust error-correcting code. (Received November 22, 2011)

1078-94-121 **Ian F. Blake*** (ifblake@ece.ubc.ca), Dept. Elec. Comp. Eng., University of British Columbia, Vancouver, BC, Canada, **Kumar Murty** (murty@math.toronto.edu), Dept. Mathematics, University of Toronto, Toronto, ON, and **Hamid Usefi** (usefi@mun.ca), Dept. Math. and Stat., Memorial University, St. John's, NL. *Rational points and codes on Hermitian surfaces*.

Given the success of constructing error correcting codes with good parameters on algebraic curves, it is natural to consider the generalization to codes on algebraic surfaces. This generalization has so far failed to produce codes with improved parameters. The problem appears to be to find a surface, whose points parameterize the code positions, together with a suitable collection of multivariate polynomials. A polynomial produces a codeword by its evaluation at the points on the surface. The relationship between the set of points and set of polynomials in order to produce a code with improved parameters, is unclear at this point. This work considers the set of points on a Hermitian surface of dimension m over the finite field \mathbb{F}_q , $q = r^2$. An expression for the zeta function of this surface is obtained as well as the generating function for a given field. The enumeration of certain subsets of points on the surface are also considered. It is hoped the subsets will prove to be of interest for code construction, which is yet to be determined. (Received November 30, 2011)

1078-94-123 **Qiuju Diao, Qin Huang and Shu Lin*** (shulin@ece.ucdavis.edu), Dept of Electrical and Computer Engineering, University of California, Davis, One Shields Ave, Davis, CA 95616, and **Khaled Abdel-Ghaffar**. *A transform approach for construction and analysis of quasi-cyclic low-density parity-check codes*.

A matrix-theoretic approach for studying quasi-cyclic codes based on matrix transformations via Fourier transforms and row and column permutations is developed. These transformations put a parity-check matrix in the form of an array of circulant matrices into a diagonal array of matrices of the same size over an extension field. The approach is amicable to the analysis and construction of quasi cyclic low-density parity-check codes since it takes into account the specific parity-check matrix used for decoding with iterative message-passing algorithms. Based on this approach, the dimension of the codes and parity-check matrices for the dual codes can be determined. Several algebraic and geometric constructions of quasi-cyclic codes are presented as applications along with simulation results showing their performance over AWGN channels decoded with iterative message-passing algorithms. (Received November 30, 2011)

1078-94-187 **Pascal O. Vontobel***, Hewlett–Packard Laboratories, 1501 Page Mill Road, Mailstop 1181, Palo Alto, CA 94304. *Approximately counting the number of constrained arrays via belief propagation*.

Reliable data communication and storage can be achieved with the help of error-correction codes and constrained codes. In this talk we focus on constrained codes for data storage, in particular on a setup which requires that every codeword is a zero-one array that satisfies certain row and column constraints. A key quantity is the number of codewords, and we investigate how well this number can be approximated with belief-propagation-based techniques. (Received December 06, 2011)

1078-94-201 **W. Cary Huffman*** (whuffma@luc.edu), Department of Mathematics and Statistics, 1032 W. Sheridan Rd., Chicago, IL 60660. \mathbb{F}_q -Linear \mathbb{F}_{q^t} -Codes with Prime Order Automorphisms. Preliminary report.

Additive codes over \mathbb{F}_4 that are self-orthogonal under a certain trace inner product lead to quantum error correcting codes. The family of \mathbb{F}_q -linear \mathbb{F}_{q^t} -codes provides a natural generalization of additive codes. Two different trace inner products on these codes are considered. The structure of a self-dual code under either of these inner products is determined when the code has an automorphism of prime order. This structure can be used to address certain classification questions. (Received December 08, 2011)

1078-94-216 **Fabian Y.C. Lim*** (flim@mit.edu) and **Manabu Hagiwara**. *Towards Delserte-type upper bounds on permutation code sizes for the Kendall-Tau distance metric*. Preliminary report.

In this talk, I will discuss Delserte-type upper bounds for permutation code sizes with respect to the Kendall-Tau distance, i.e. the minimum number of adjacent transpositions needed to go between permutations. We look at the coherent configurations that result from symmetries of this particular distance metric. By stipulating a set of possible distances between permutations, these coherent configurations lead to optimization problems that deliver upper bounds on code sizes. In general, computing these upper bounds requires consideration of optimization constraints that enforce positive semidefiniteness on certain related matrices. As compared with optimization problems considered by Delserte (in his seminal work on binary codes), the problems here are harder to deal with. I will talk about a particular simplification of these problems that lead to weaker upper bounds; this simplification modifies the positive semidefiniteness constraints into more manageable linear constraints. I will discuss the strength of this particular technique, as well as directions for future improvements. (Received December 10, 2011)

1078-94-217 **Tadashi Wadayama*** (wadayama@nitech.ac.jp), Gokiso, Syowa-ku, Nagoya, Aichi 4668555, Japan, and **Manabu Hagiwara** (hagiwara.hagiwara@aist.go.jp), Central 2, 1-1-1 Umezono, Tsukuba, Ibaraki 305-8568, Japan. *LP decodable permutation codes based on linearly constrained permutation matrices*.

A set of linearly constrained permutation matrices are proposed for constructing a class of permutation codes. The main feature of this class of permutation codes, called *LP decodable permutation codes*, is this linear programming (LP) decodability. It is demonstrated that the LP decoding performance of the proposed class of permutation codes is characterized by the vertices of the code polytope of the code. Two types of linear constraints are discussed; one is structured constraints and the other is random constraints. The structured constraints allow an efficient encoding algorithm. On the other hand, the random constraints enable us to use probabilistic methods for analyzing several code properties such as the average cardinality and the average weight distribution. (Received December 08, 2011)

1078-94-223 **Koji Chinen*** (chinen@math.kindai.ac.jp), Kowakae 3-4-1, Higashi-Osaka, 577-8502, Japan. *Zeta functions for linear codes and their generalizations*.

Zeta functions for linear codes are defined by Iwan Duursma in 1999. They are generating functions of Hamming weight enumerators of codes. They can also be defined for other homogeneous polynomials not corresponding to existing codes. For the existing codes, their Riemann hypothesis is believed to be closely related to the extremal property.

In this talk, we review some basic properties of zeta functions for linear codes and discuss some generalizations of them. Especially, we show that there are many invariant polynomials which satisfy the Riemann hypothesis. (Received December 09, 2011)

1078-94-241 **Manabu Hagiwara***, Dept. of Mathematics, Univ. of Hawaii, C/O J.B. Nation, 2565 McCarthy Mall, Honolulu, HI 96822. *Graphical construction of permutation code*.

Recently, Wadayama found the fundamental theorem on decoding method of permutation code by using Linear Programming technique. The decoding method shall be ML-decoding for a sub-polytope of Birkhoff polytope if the vertex set of the sub-polytope is a subset of permutation matrices. However, in general, it is difficult to construct such a nice sub-polytope. In this talk, a construction method of a class of such nice sub-polytope by using a graph will be discussed. Hence a new class of permutation code is obtained. (Received December 10, 2011)

1078-94-242 **Yuichiro Fujiwara*** (yfujiwar@mtu.edu), 1400 Townsend Drive, Houghton, MI 49931. *A combinatorial approach to entanglement-assisted quantum low-density parity-check codes*.

The entanglement-assisted stabilizer formalism is a generalized form of the stabilizer formalism for quantum error correction. This framework makes it possible to import any binary or quaternary linear codes into the quantum domain by exploiting pairs of qubits in a maximally entangled state (or ebits). Low-density parity-check (LDPC) codes are among the best known classical error-correcting codes in terms of error correction performance and decoding complexity and can also be imported into the quantum domain in a simple manner through the entanglement-assisted stabilizer formalism. Because excessive reliance on ebits can be an obstacle for implementation, it is desirable to use fewer ebits while keeping high error correction ability. We present necessary and sufficient conditions for the existence of quantum LDPC codes consuming only one ebit with the largest possible girth which are obtainable from pairs of identical LDPC codes, and give explicit constructions based

on finite geometry. We also show relations of entanglement-assisted quantum LDPC codes to some fundamental classes of combinatorial designs. (Received December 10, 2011)

1078-94-353 **Wataru Matsumoto*** (Matsumoto.Wataru@aj.MitsubishiElectric.co.jp), 5-1-1, Ofuna, Kamakura, Kanagawa 247-8501, Japan. *Forward error correction codes on high-speed communication standards and the future issues.*

I introduce forward error correction (FEC) codes which have been used in many recent high-speed communication standards, such as digital video broadcasting systems, optical communication systems, wireless communication systems, and so on. The issues of FEC codes for future communications and other applications are described mathematically. (Received December 13, 2011)

1078-94-360 **Christine A. Kelley*** (ckelley2@math.unl.edu), Department of Mathematics, 203 Avery Hall, Lincoln, NE 68588. *Algebraic LDPC codes based on non-commuting permutation matrices.*

Over the last decade, much research has focused on the design of graph-based codes using lifts of specially chosen base graphs. In this talk we will look at using algebraic lifts of graphs for codes designed from non-commuting permutation matrices. We will discuss some new results on the properties of these codes. (Received December 13, 2011)

97 ► *Mathematics education*

1078-97-8 **Tara C Davis*** (taracdavis@gmail.com), Honolulu, HI 96813, and **Hung Lu** (hlu@hpu.edu), Honolulu, HI 96813. *Student-centered versus instructor-centered approaches to teaching mathematics.* Preliminary report.

This action research study focuses on exploring whether the student-centered approaches such as group work, and individual in-class problem solving are more effective than the traditional instructor-centered lecture approach in our math classes. We are interested in learning whether students have higher levels of confidence and lower levels of math anxiety when taught more actively. In addition, we seek to understand the correlation between students' performance and preference between the two approaches. The study was conducted with 70 students at Vanderbilt University during the 2009-2010 academic year and will be conducted with approximately 90 students at Hawaii Pacific University in the Fall of 2011. The preliminary results indicated an interesting dichotomy between students' performance and their preference when being taught using the student-centered approach. Regardless of their better performance, students showed less preference for the student-centered approach. (Received August 30, 2011)

1078-97-63 **Diane Barrett*** (diane.barrett@hawaii.edu), Education Department, University of Hawaii at Hilo, 200 W. Kawili St., Hilo, HI 96720. *Using manipulatives to promote meaningful mathematics instruction.*

This pilot study examined the contents of and feedback for a professional development workshop designed to help in-service teachers use manipulatives to develop and deepen their students' understanding of mathematical concepts taught in the classroom. Teachers from the West Hawai'i complex area (Kohala, Honoka'a, Kealoheke, and Konawaena) on the Big Island of Hawai'i focused on select algebra, geometry, and numbers and operations standards and how to address them by actively engaging learners with mathematics manipulatives, such as pattern blocks and patty paper, at multiple grade levels. Guidelines for the educationally sound use of mathematics manipulatives and how to assess for student understanding were also addressed. Reflections on the strengths and weaknesses of the workshop were explored. (Received November 25, 2011)

1078-97-68 **Kris H. Green*** (kgreen@sjfc.edu), 3690 East Ave, Rochester, NY 14618. *The Un-Common Mathematics Core Curriculum.*

The Common Core Standards Initiative has produced standards to drive 21st century mathematics preparation. At the time of this writing, over 80% of states have adopted the common core. But changing the standards is only one small step toward improving mathematics teaching. Standards must be implemented effectively. Thus, teachers and teacher candidates must understand these new standards and what they represent. It is not simply a new "scope and sequence" document or a "top-down curriculum." The Common Core represents a new way of thinking about mathematics and mathematics teaching. In this talk, I will give a brief background of the movement toward the Common Core. The talk will then focus on how teachers can best align the goals of the Common Core with the reality of their teaching and assessment through the use of the Revised Bloom's Taxonomy (Anderson & Krathwohl, 2001). (Received November 18, 2011)

1078-97-85 **Brendan J Foreman*** (bforeman@jcu.edu), Department of Mathematics and Computer Scienc, 20700 N. Park Boulevard, University Heights, OH 44118. *A Deweyan approach to teaching mathematics to early childhood education majors*. Preliminary report.

In this talk, I will describe my experiences as a mathematics professor in designing and implementing a mathematics course for early childhood education majors which incorporates the development of mathematical understanding by young children with a deep exploration of what mathematics is and how advanced mathematical concepts have developed from these foundations. Based in structure around the course of human mathematical learning, this course covers all of the “usual suspects” of courses of this type (e.g., the structure of the real number system), while exploring how these concepts emerge from and interact with young learners. This approach is fundamentally Deweyan in its emphasis on experience and community-based learning. Time permitting, I will explain several of my efforts to determine the effectiveness of this approach to teaching the material versus more traditional approaches. (Received November 22, 2011)

1078-97-108 **Laurie Riggs*** (lriggs@csupomona.edu), Department of Mathematics and Statistics, 3801 West Temple Ave., Pomona, CA 91768. *Using technology to build understanding in teaching and learning mathematics*. Preliminary report.

Teachers and future teachers need a deep understanding of the mathematics they are to teach. If they only have algorithms and rules for doing mathematics that is what they will transfer to their students. Future teachers need opportunities to explore and engage in mathematics in order to develop their own conceptual knowledge. The use of technology in the university classroom for demonstration and exploratory projects can help teachers build a strong knowledge base. It can also be used to model teaching strategies that can be used in their own classrooms.

This session will demonstrate the use of technology to support the teaching and learning of mathematics. We will see sample projects and demonstration models that build key concepts. Teacher developed models will also be shared along with preliminary results from an action research project involving the use of technology to teach mathematics in a middle school. (Received November 28, 2011)

1078-97-250 **Erica L Johnson*** (ejohnson@sjfc.edu), St. John Fisher College, Dept of Mathematical & Computing Sciences, 3690 East Avenue, Rochester, NY 14618. *Making and breaking codes: Something for everyone*. Preliminary report.

The art and science of encoding and decoding secret messages has intrigued humanity for millennia. Students are no exception. The mathematical content is appropriate for a variety of ages and mathematical backgrounds. A modern method, RSA, a form of Public Key Encryption, is an application of modular arithmetic that has its roots in Number Theory. Number Theory is a subject that is rife with opportunities for students to engage in inquiry-based learning, mathematical proof and reasoning, and problem solving. The mathematical content behind RSA builds off of elementary school content and is an extension of high school curriculum that also speaks to the infamous question, “Where are we ever going to use this?” Technology is an integral part of current encryption methods and can be harnessed to foster student understanding. In this talk, we will present and/or recreate several encryption methods used through history culminating in RSA, a form of Public Key Encryption, a method which is currently in use today. Additionally the mathematical, curricular, and pedagogical utility of said encryption methods will be discussed. (Received December 10, 2011)

1078-97-307 **Roberto C Pelayo*** (robertop@hawaii.edu), University of Hawai'i at Hilo, Mathematics Department, 200 W. Kawili St., Hilo, HI 96720, and **Matthew Haslam** (mhaslam@hawaii.edu), University of Hawai'i at Hilo, English Department, 200 W. Kawili St., Hilo, HI 96720. *A bottom-up approach to mathematical writing*.

Recently, much work has been done to effectively introduce writing into mathematical learning. Of these approaches, few focus on how mathematical writing enables the student learner to become a knowledge creator, as opposed to a knowledge consumer. To this end, the authors developed a curriculum for a summer transitional course in Pre-Calculus consisting of three major components: a mathematics workshop, learning logs, and mathematical discourse. In the workshop, students enter a collaborative environment in which individual computation serves as data for abstraction. Articulated in the Learning Logs, carefully scaffolded problems ask the student learners to generalize their computations into more symbolic theorems. Via these logs, trained teaching assistants enter into a discourse with the students, challenging their abstractions under more general and nuanced hypotheses. This framework gives the student the role of a knowledge creator, constructing his or her own generalizations and theorems. In this talk, we will present elements of this curriculum, along with various writing samples and results that illustrate its effectiveness. This talk will also touch on many of the

cognitive psychological aspects of this “bottom-up” approach to mathematical learning. (Received December 12, 2011)

1078-97-371 **Dian Calkins*** (dcalkins@dominican.edu) and **Sibdas Ghosh**. *Graphic literacy: Mathematic modeling for the liberal arts.*

Graphic Literacy: Mathematic Modeling for the Liberal Arts There is now a radical shift in the purpose as well as the content of a Liberal Arts education. Students must do more than become knowledgeable about the work done in their field; they must enlarge the impact their knowledge and their field can have on solving problems. Our world community will need insightful analysis of challenges, requiring, as Steve Jobs noted, that we “think different.”

Mathematics, the language in which science came to exist, now drives the design and process of problem solving, in every field.

Math becomes a laboratory discipline, brought to every student through the astounding power of technology to reveal pattern and change of all kinds. Liberal Arts students developing mathematic perspective and analytic modeling skills will be the innovators in their fields. Graphic representation for study and research will be a basic tenet of their Liberal Arts undergraduate experience.

A course in modeling should include a review of historic problems investigated and solved through graphing, practice in translation between literal and graphic representation, and an active-learning research experience in organizing and studying a current problem or situation in a student’s chosen field. (Received December 13, 2011)

1078-97-398 **Mitchell J Anderson*** (mitch@hawaii.edu), UHH, 200 W. Kawili St., Hilo, HI 96720. *Transitioning to the common core – Opportunities and challenges.*

In service High School teachers transitioning to the new mathematics Common Core face numerous challenges. This talk explores the most severe challenges ranging from the need to refresh and sometimes enhance content area, to developing new curriculum and adapting pedagogy in order to accommodate the importance of the conceptual aspects of high school mathematics. The emphasis within the new common core on understanding conceptual mathematics at a deeper level represents a definite shift, and those teachers whose primary pedagogy has been to present algorithmic symbolic manipulation will be particularly challenged to develop instructional material that requires deeper thought and understanding of their students. Of particular difficulty will be developing new curriculum and assessment mechanisms that reflect this new emphasis. The author outlines the most severe challenges and offers suggestions for addressing the most severe shortfalls. (Received December 13, 2011)

TAMPA, FL, March 10–11, 2012

Abstracts of the 1079th Meeting.

00 ► General

1079-00-214 **Christopher John Gillam*** (cgillam@clemsun.edu), O-110 Martin Hall, Box 340975, Clemson, SC 29634. *Wave Direction-based Reconstruction of Stiffness in Magnetic Resonance Elastography.*

Magnetic Resonance Elastography is a useful noninvasive medical diagnosis technique for detecting early stage cancer by comparing the stiffness of tissue. In Magnetic Resonance Elastography, a vibrating transducer sends the wave into the body which is captured by the motion encoding gradient. Our goal is to reconstruct the stiffness distribution from the interior wave. On a small window, a simple one dimensional minimization is used to calculate the wave direction. Using the wave direction, a Fourier transform technique will reconstruct the local stiffness. Compared to another known algebraic direct inversion technique, this presented reconstruction is resilient to noise and more accurate in reconstructed stiffness value. Moreover, when combined with the known direct inversion method, it provides a stable and improved reconstruction in shape and value. These reconstruction methods are tested using simulations under noisy conditions and with data provided from the Mayo Clinic. (Received January 13, 2012)

1079-00-370 **Jasun Gong*** (jasun.gong@aalto.fi), Aalto University, Institute of Mathematics, P.O. Box 11100, 00076 Aalto Helsinki, Finland, and **Thomas Bieske** (tbieske@mail.usf.edu), Department of Mathematics & Statistics, University of South Florida, 4202 E Fowler Ave, PHY114, Tampa, FL 33620-5700. *Opening Remarks on Sub-Riemannian Geometry and other Metric Spaces.*

This is an expository talk aimed at a general audience. It is intended as the background material for further presentations in this Special Session.

Our focus will be on sub-Riemannian manifolds, which are spaces equipped with smooth structures yet exhibit rather unique metric properties. In addition to their role in modern geometry, such spaces also arise in control theory and other applications, such as models of human vision.

Specifically we will address basic properties of sub-Riemannian manifolds, such as the Chow-Rashevskii and Ball-Box Theorems, along with several well-known examples such as the (first) Heisenberg group. We will also discuss the connection between these spaces and certain partial differential equations, a subject that will be further explored in later talks.

If time permits, we will also discuss metric spaces in greater generality. Despite the lack of smooth or Euclidean structures, a rich first-order theory of calculus remains valid for a large class of spaces, which leads to interesting problems in geometry. (Received January 18, 2012)

03 ► Mathematical logic and foundations

1079-03-18 **Serap Tutkun*** (serapmat89@gmail.com), Ege University, Department of Mathematics, 35100 Izmir, Izmir, Turkey, and **Ahmet Yildirim** and **Praveen Kumar Gupta**. *Analytical approach to multi-dimensional fractional Helmholtz equation.*

The article presents the approximate analytical solution of a multidimensional partial differential equation such as Helmholtz equation with space fractional derivatives. By using initial and boundary values, the explicit solutions of the equation are solved with powerful mathematical tools like He's homotopy perturbation method (HPM). The results reveal that the HPM is demonstrate the effectiveness, validity, potentiality and reliability of the method in reality and gives the exact solution. (Received October 16, 2011)

1079-03-89 **Michael Hugh Knowles*** (mhk@mhknowles.net), Rua Miradouro, 45, Sion, Belo Horizonte, MG 30310-640, Brazil. *Does the Banach-Tarski Paradox have an Evil Twin?!*

New theorem on bijections: if the pre-image and image sets SP and SI of a bijection B(SP,SI) have an element EC in common, then one can construct a bijection from the pre-image set with EC removed onto the image set with EC removed, i.e. $B^*(SP-\{EC\}, SI-\{EC\})$. Simple proof: if EC is identity subbijection onto EC under B, this identity subbijection is removed, trivially constructing the desired bijection, $B^*(SP-\{EC\}, SI-\{EC\})$. But,

if EC is subbjected onto some other image element EI , then some other pre-image element EP is subbjected onto EC . We switch the pre-image EC and EP , preserving bijectivity. This yields a bijection $B'(SP,SI)$, with EP subbjected onto EI , and EC identity subbjected onto EC . Again this identity subbjection from EC onto EC is removed from $B'(SP,SI)$, trivially constructing the desired $B^*(SP-\{EC\},SI-\{EC\})$. We apply this theorem to a “Dedekind-infinite bijection” (a bijection from a set SD onto a proper subset of itself, showing that SD is Dedekind-infinite) so as to remove all common elements. We obtain a “Paradoxical Bijection” from a non-empty set onto the empty set, the Evil Twin of the Banach-Tarski Paradox, and a challenging new paradox for the community. (Received December 21, 2011)

05 ► *Combinatorics*

1079-05-2 **Mark Ellingham*** (mark.ellingham@vanderbilt.edu), Department of Mathematics, 1326 Stevenson Center, Vanderbilt University, Nashville, TN 37240. *Beyond the Map Color Theorem.*

The Map Color Theorem extends the Four Color Theorem to arbitrary surfaces. For the plane (or sphere) it is easy to prove that four colors may be necessary to color a map, but very hard to prove that four colors are sufficient. Surprisingly, for other surfaces the situation is reversed: it is easy to prove that a certain number of colors is sufficient, but hard to prove that it is necessary. Proving necessity turns out to be equivalent to determining the genus (orientable or nonorientable) of the complete graph K_n , i.e., the genus of the simplest surface in which K_n can be embedded. Doing this took nearly eighty years and the efforts of a number of people, and required the development of algebraic methods to construct graph embeddings. The project was completed by Ringel and Youngs in 1968. In this talk we survey results that extend the determination of the genus of the complete graphs in various ways, such as finding large families of graphs for which the genus can be determined, and finding many different embeddings of graphs in their minimum genus surfaces. We discuss some of the tools that have been used. The results include work of the speaker in collaboration with Justin Schroeder, Chris Stephens, Adam Weaver and Xiaoya Zha. (Received August 01, 2011)

1079-05-21 **Benjamin J Wyser*** (bwyser@math.uga.edu), Department of Mathematics, University of Georgia, Boyd Graduate Studies Research Center, Athens, GA 30602-7403. *$GL(p, \mathbb{C}) \times GL(q, \mathbb{C})$ -orbits on the flag variety and Schubert structure constants for (p, q) -pairs.*

Let G be a complex, reductive algebraic group, and let $\theta : G \rightarrow G$ be an involution of G . The fixed point subgroup $K = G^\theta$ is referred to as a symmetric subgroup of G . K acts on the flag variety G/B with finitely many orbits. The geometry of these orbits and their closures plays an important role in the infinite-dimensional representation theory of a certain real form of G .

One interesting example of a symmetric pair is $(G, K) = (GL(p+q, \mathbb{C}), GL(p, \mathbb{C}) \times GL(q, \mathbb{C}))$. Restricting attention to this example, I will discuss a recent result which establishes that a number of the K -orbit closures in this case coincide with certain Richardson varieties. When combined with a theorem of M. Brion on expressing the class of such an orbit closure in the basis of Schubert cycles, this observation implies a positive (indeed, multiplicity-free) rule for certain Schubert structure constants $c_{u,v}^w$ — those for which u, v form what I refer to as a “ (p, q) -pair”. (Received October 31, 2011)

1079-05-32 **Mahir Bilen Can** (mcan@tulane.edu), Tulane University Mathematics Department, 424 Gibson Hall, New Orleans, LA 70118, and **Michael Orin Joyce*** (mjoyce3@tulane.edu), Tulane University Mathematics Department, 424 Gibson Hall, New Orleans, LA 70118. *Combinatorics of the Weak Bruhat Order on the Variety of Complete Quadrics.*

The action of the projective general linear group on the variety of complete quadrics gives rise to an action of the Richardson-Springer monoid associated to the symmetric group on sets of generalized involutions. We study the associated weak Bruhat order of this action and characterize the maximal chains. We apply this characterization to cohomological calculations modeled after the Lascoux-Schutzenberger divided difference calculus. (Received November 22, 2011)

1079-05-37 **Michael W Schroeder*** (schroederm@marshall.edu), Huntington, WV 25703. *Symmetric Hamilton Cycle Decompositions of General Cocktail Party Graphs.* Preliminary report.

Let $G = K_{2n} - F$ be the cocktail party graph. A Hamilton cycle C of G is *symmetric* if C is invariant as an edge set under the involution defined by the missing 1-factor F . It has been shown that G has a symmetric Hamilton cycle decomposition if and only if $n \equiv 1$ or $2 \pmod{4}$. We relax the definition of a symmetric Hamilton

cycle to mean C is ϕ -invariant, where ϕ is an order 2 fixed-point free automorphism which commutes with the previous involution. We show that with this relaxation, every cocktail party graph has a relaxed symmetric decomposition. (Received November 28, 2011)

1079-05-43 **Sarah Crown Rundell*** (rundells@denison.edu), 100 West College St, Department of Mathematics, Denison University, Granville, OH 43023. *The coloring complex of a hypergraph.*

Let G be a graph with n vertices and at least one edge. The coloring complex $\Delta(G)$ was defined by Steingrímsson, and is a simplicial complex that is associated to G whose r -faces consist of all ordered set partitions $[B_1, \dots, B_{r+2}]$ of the vertices of G so that at least one of the B_i contains an edge of G . Jonsson showed that $\Delta(G)$ is a constructible complex, and the rank of the unique nontrivial homology group is $|\chi_G(-1)| - 1$, where $\chi_G(\lambda)$ denotes the chromatic polynomial of G . Let H be a hypergraph with n vertices. In this talk, we define the coloring complex of a hypergraph, $\Delta(H)$, and we will discuss its homology. In particular, in the case where the hypergraph is a complete k -uniform hypergraph, $\Delta(H)$ is a shellable complex, and the rank of its unique nontrivial homology group can be expressed in terms of the chromatic polynomial of H . Using the Eulerian idempotents, one can place a decomposition on this nonzero homology group, and the rank of the j^{th} component in this decomposition equals the absolute value of the coefficient of λ^j in the chromatic polynomial of H . We also will discuss the homology of the cyclic coloring complex of a complete k -uniform hypergraph. (Received December 02, 2011)

1079-05-46 **Jean-Guillaume Eon*** (jgeon@iq.ufrj.br), Avenida Athos da Silveira Ramos, 149 Bloco A, Cidade Universitária, Rio de Janeiro, 21941-909, Brazil, and **Montauban Oliveira Jr**, Rio de Janeiro, Brazil. *Non-crystallographic nets with a system of imprimitivity for bounded automorphisms.*

A p -periodic net is a pair (N, T) , where N is a net, $T \leq \text{Aut}(N)$ is a free abelian group of automorphisms of rank p such that the quotient graph $G = N/T$ is finite. p -Periodic nets are called crystallographic or non-crystallographic nets according as their automorphism group is respectively isomorphic or not, to some p -dimensional space-group. An automorphism g of N is said to be bounded if the set of distances $\{d[g(u), u] | u \in V(N)\}$ is bounded in \mathbb{N} . Let $B(N)$ be the subgroup of bounded automorphisms of a periodic net N . A partition σ of $V(N)$ is a system of imprimitivity for $G \leq B(N)$ if $g(u)$ belongs to the same subset (block) of σ as u for every $g \in G$ and $u \in V(N)$. A barycentric representation of a periodic net N in Euclidian space \mathbb{E} is a mapping ρ of the vertex set $V(N)$ in \mathbb{E} such that $r(u)\rho(u) = \sum_{v \sim u} \rho(v)$, where $r(u)$ is the degree of vertex u and the sum is performed over the set of adjacent vertices v of u . We will show that periodic, barycentric representations of non-crystallographic nets with a non-trivial, periodic system of imprimitivity display vertex collisions, every block being represented as a single point. (Received December 05, 2011)

1079-05-49 **Mohit Kumbhat*** (kumbhat2@illinois.edu), 1409 W Green St, Urbana, IL 61801, **Zoltan Füredi** (z-furedi@illinois.edu), 1409 W Green St, Urbana, IL 61801, and **Alexander Kostochka** (kostochk@illinois.edu), 1409 W Green St, Urbana, IL 61801. *Choosability with separation in graphs and hypergraphs.*

For a hypergraph G and a positive integer s , let $\chi_\ell(G, s)$ be the minimum value of l such that G is L -colorable from every list L with $|L(v)| = l$ for each $v \in V(G)$ and $|L(u) \cap L(v)| \leq s$ for all $u, v \in e \in E(G)$. This parameter was studied by Kratochvíl, Tuza and Voigt for various kinds of graphs. In this talk, we present the asymptotics of $\chi_\ell(G, s)$ for complete graphs, balanced complete multipartite graphs and complete k -partite k -uniform hypergraphs. This is a joint work with Z. Füredi and A. Kostochka. (Received December 08, 2011)

1079-05-56 **Feliú Davino Sagols*** (fsagols@math.cinvestav.mx), Av. IPN 2508 Col. San Pedro Zacatenco, 07360 Mexico City, Mexico, Mexico, **Javier Muñoz-Bernabe** (javmunozb@hotmail.com), Av. IPN No. 2508 Col San Pedro Zacatenco, 07360 Mexico City, Mexico, Mexico, and **Charles J Colbourn** (Charles.Colbourn@asu.edu), Po Box 878809, Tempe, Arizona, U.S.A., Tempe, AZ. *Ideals, varieties, stability, colorings and combinatorial designs.* Preliminary report.

A combinatorial design is equivalent to a stable set in a suitably chosen Johnson graph, whose vertices correspond to all k -sets that could be blocks of the design. In order to find maximum stable sets of a graph G , two ideals are associated with G , one constructed from the Motzkin-Strauss formula and one reported by Lovász in connection with the stability polytope. These ideals are shown to coincide and form the *stability ideal* of G . Graph stability ideals belong to the class of ideals of boolean rings.

Stability ideals of Johnson graphs provide an algebraic characterization that can be used to generate Steiner triple systems. Two different ideals for the generation of Steiner triple systems, and a third for Kirkman triple systems, are developed. The last of these combines stability and colorings.

We use these approaches in connection to genetic algorithms and the Polybori software to generate big order Steiner Triple Systems. (Received December 12, 2011)

1079-05-57 **Nina Schmuck, Stephan Wagner and Hua Wang*** (hwang@georgiasouthern.edu).
Distance-based functions of trees.

We show a “universal property” of the greedy tree with a given degree sequence, namely that the number of pairs of vertices whose distance is at most k is maximized by the greedy tree for all k . This rather strong assertion immediately implies, and is equivalent to, the minimality of the greedy trees with respect to graph invariants of the form $W_f(T) = \sum_{\{u,v\} \subseteq V(T)} f(d(u,v))$ for any nonnegative, nondecreasing function f . With different choices of f , one directly solves the minimization problems of distance-based graph invariants including the classical Wiener index, the Hyper-Wiener index and the generalized Wiener index. (Received December 13, 2011)

1079-05-67 **Natasha Rozhkovskaya*** (rozhkovs@math.ksu.edu), 138 Cardwell hall, Manhattan, KS 66502. *Characteristic maps for the Brauer algebra.*

The classical characteristic map associates symmetric functions to characters of the symmetric groups. There are two natural analogues of this map involving the Brauer algebra. The first of them relies on the action of the orthogonal or symplectic group on a space of tensors, while the second is provided by the action of this group on the symmetric algebra of the corresponding Lie algebra. We consider the second characteristic map both in the orthogonal and symplectic case, and calculate the images of central idempotents of the Brauer algebra in terms of the Schur polynomials. This is joint work with A. Molev (Received December 15, 2011)

1079-05-74 **Xiang-dong Hou*** (xhou@usf.edu). *Classification of self dual quadratic bent functions.*

Let p be a prime and $\omega = e^{2\pi i/p}$. A bent function on \mathbb{F}_p^n is called (γ, u) -self dual, where $\gamma \in \mathbb{C}$, $|\gamma| = 1$, $u \in \mathbb{F}_p^*$, if $\sum_{x \in \mathbb{F}_p^n} \omega^{f(x)+xy^T} = \gamma p^{n/2} \omega^{uf(y)}$ for all $y \in \mathbb{F}_p^n$. The orthogonal group $O(n, \mathbb{F}_p)$ acts on the set of all (γ, u) -self dual bent functions. We classify all self dual quadratic bent functions on \mathbb{F}_p^n under this action. The sizes of the $O(n, \mathbb{F}_p)$ -orbits of such self dual bent functions are explicitly determined. (Received December 16, 2011)

1079-05-82 **Jonathan Comes**, Dept. of Mathematics, University of Oregon, Eugene, OR, and
Jonathan Kujawa*, Dept. of Mathematics, University of Oklahoma, Norman, OK.
Modified traces on Deligne’s category $\text{Rep}(S_t)$.

For a complex parameter, t , Deligne combinatorially defined a category, $\text{Rep}(S_t)$, which “interpolates” among the representations of the various symmetric groups. We discuss these interesting categories and how they admit nontrivial modified trace and dimension functions. As an easy application, we use them to recover the knot invariant known as the writh. (Received December 20, 2011)

1079-05-104 **David J Galvin***, Department of Mathematics, University of Notre Dame, Notre Dame, IN 46556, and **John Engbers**. *The independent set profile in graphs with given minimum degree.*

Which graphs in a given family admit the most independent sets? This extremal question has been addressed for many families, including for example trees, regular graphs, graphs with a given number of edges, and graphs with given minimum degree.

A refinement of this questions asks: which graphs admit the most independent sets of each possible size? Often (but not always), the graph in a given family which maximizes the total number of independent sets also maximizes the number of each possible size.

In this talk we will discuss these two extremal questions, focussing particularly on our recent work (joint with John Engbers) on the family of graphs on a fixed number of vertices with a given minimum degree. (Received December 29, 2011)

1079-05-111 **Yoshiro Yaguchi*** (yaguchi-y@hiroshima-u.ac.jp), Saijyo Shitami 5-9-26-107, Higashi-Hiroshima, Hiroshima 739-0044, Japan. *Homological invariants of Hurwitz action on tuples of simple braids.*

Hurwitz equivalence on systems of simple braids is studied, which can be used in the study of surface braids and surface links. In this talk, we define a matrix for a system of simple braids by using the first homology classes of a punctured disk. As applications, we give some invariants of surface braids by using the matrices obtained from the systems of their braid monodromies. (Received January 02, 2012)

1079-05-112 **Paul Feit*** (feit_p@utpb.edu), Department of Mathematics, 4901 East University Blvd., Odessa, TX 79762. *Canonical Graphs for Resolving Lists with Specified Distances.*

We define a *baseline matrix* to be a symmetric matrix with certain properties.

A *metric selection* is a triple $(r, \Gamma; w_1, \dots, w_r)$ in which Γ is a finite connected graph and w_1, \dots, w_r is a list of vertices. Let ρ be the shortest path metric of Γ . We say that w_1, \dots, w_r *resolves* Γ if the *code map* on vertices $x \in V(\Gamma)$

$$x \mapsto (\rho(w_1, x), \dots, \rho(w_r, x))$$

is injective. Also, the $r \times r$ matrix $[\rho(w_i, w_j)]$ is a baseline matrix; refer to it as the *baseline of the selection*.

For a fixed baseline matrix B and an integer d greater than all of B 's entries, we find a metric selection $(r, \Gamma(B, d); e_1, \dots, e_r)$ which (1) is resolved, (2) has diameter d , and (3) has a universal property: If $(r, \Gamma, w_1, \dots, w_r)$ is a metric selection whose baseline equals B , and whose diameter is $\leq d$, then there is a unique graph injection $f : \Gamma \rightarrow \Lambda$ which commutes with the code maps of the respective selections.

This family of “canonical graphs” includes those used by **[Hernando et al]** in proving sharp bounds on the number of vertices of a metric dimension r graph of diameter d . (Received January 02, 2012)

1079-05-113 **Jun Fujisawa, Michael D. Plummer*** (michael.d.plummer@vanderbilt.edu) and **Akira Saito.** *Forbidden Subgraphs Generating a Finite Set.*

Given a set \mathcal{F} of connected graphs, a graph G is said to be \mathcal{F} -free if G contains no member of \mathcal{F} as an induced subgraph. The members of \mathcal{F} are then referred to as forbidden subgraphs. Denote by $\mathcal{G}_k(\mathcal{F})$ the family of all k -connected \mathcal{F} -free graphs. The reader is surely familiar with theorems of the form stating that if $G \in \mathcal{G}_k(\mathcal{F})$ and $|V(G)|$ is sufficiently large, then G satisfies a given property P . But if $\mathcal{G}_k(\mathcal{F})$ itself is finite, such a theorem gives little information about the property P . With this in mind we study the sets \mathcal{F} with finite $\mathcal{G}_k(\mathcal{F})$.

We prove that if $|\mathcal{F}| \leq 2$ and $\mathcal{G}_k(\mathcal{F})$ is finite, then either $K_{1,2} \in \mathcal{F}$ or else \mathcal{F} consists of a complete graph and a star. For each of the values of k , $1 \leq k \leq 6$, we then characterize all pairs $\{K_\ell, K_{1,m}\}$ such that $\mathcal{G}_k(\{K_\ell, K_{1,m}\})$ is finite. We also give a complete characterization of \mathcal{F} such that $|\mathcal{F}| \leq 3$ and $\mathcal{G}_2(\mathcal{F})$ is finite. (Received January 02, 2012)

1079-05-114 **Marina Dombrovskaya*** (dombrom@math.wustl.edu). *Quotients of subgroup lattices of finite abelian p -groups.* Preliminary report.

Let G be a finite abelian p -group of type λ . It is well-known that the lattice $L_\lambda(p)$ of subgroups of G is the order-theoretic p -analogue of the chain product $[0, \lambda]$. However, any surjection $\varphi : L_\lambda(p) \rightarrow [0, \lambda]$ with order analogue properties does not respect group automorphisms. We are interested in $\overline{L_\lambda(p)}$, the quotient lattice of $L_\lambda(p)$ under the action of a Sylow p -subgroup of the automorphism group of G . This quotient lattice is particularly interesting since it respects group automorphisms, has the property that the size of an orbit of the action is a power of p , and is closely related to the product of chains $[0, \lambda]$. We will discuss combinatorial properties of $\overline{L_\lambda(p)}$ and several other interesting quotients of $L_\lambda(p)$ that arise as a consequence of studying $\overline{L_\lambda(p)}$. (Received January 02, 2012)

1079-05-118 **Eunjeong Yi*** (yie@tamug.edu), Texas A&M University at Galveston, Galveston, TX 77553. *On Zero Forcing Number of Functigraphs.* Preliminary report.

Zero forcing number, $Z(G)$, of a graph G is the minimum cardinality of a set S of black vertices (whereas vertices in $V(G) \setminus S$ are colored white) such that $V(G)$ is turned black after finitely many applications of “the color-change rule”: a white vertex is converted black if it is the only white neighbor of a black vertex. Zero forcing number was introduced and used to bound the minimum rank of graphs by the “AIM Minimum Rank – Special Graphs Work Group”. Let G_1 and G_2 be disjoint copies of a graph G and let $f : V(G_1) \rightarrow V(G_2)$ be a function. Then a *functigraph* $C(G, f) = (V, E)$ has the vertex set $V = V(G_1) \cup V(G_2)$ and the edge set $E = E(G_1) \cup E(G_2) \cup \{uv \mid v = f(u)\}$. We study how zero forcing number behaves in passing from G to $C(G, f)$ by first showing that $1 + \delta(G) \leq Z(C(G, f)) \leq 2n - 2$, if G is a connected graph of order $n \geq 3$ and f is any function; here $\delta(G)$ is the minimum degree of G . We further investigate the zero forcing number of functigraphs on complete graphs, on cycles, and on paths. (Received January 13, 2012)

1079-05-123 **Toshikazu Sunada*** (sunada@math.meiji.ac.jp). *Discrete Abel-Jacobi maps and Crystallography.*

From the mathematical view, a crystal structure as a graph (a 1-dimensional cell complex or a network, in other words) is simply an abelian covering graph over a finite graph. Among infinitely many possible placements in space of a given crystal structure, there is a “canonical” one which is characterized by a certain minimal principle, and was used to describe asymptotic behaviors of simple random walks on crystal lattices (M. Kotani and T. Sunada, 2000). This talk will address some recent results about the canonical placement of the maximal

abelian covering graph over a finite graph. It is observed that the canonical placement is closely related to an analogue of Abel-Jacobi maps in algebraic geometry, which is a map (morphism) from the finite graph into the Cayley graph associated with a finite abelian group. (Received January 04, 2012)

1079-05-128 **Bert L Hartnell*** (Bert.Hartnell@smu.ca), 923 Robie St., Halifax, N.S. B2W 2K4, Canada, and **Douglas F Rall**. *Graphs with exactly t different sizes of maximal independent sets of vertices.*

We say that a graph G is in the collection M_t if there are precisely t different sizes of maximal independent sets of vertices in G . Thus the M_1 graphs are the well-covered ones (introduced by M. Plummer) where all the maximal independent sets are of one size. We examine graphs of higher girth belonging to M_t in the situation that the minimum degree is at least two. (Received January 05, 2012)

1079-05-130 **Miklos Bona*** (bona@uf1.edu). *How the absence of a permutation pattern influences the number of occurrences of another.*

Following a question of Joshua Cooper, we study the expected number $E_{q,r}(n)$ of occurrences of a given permutation pattern q in permutations that avoid another given pattern r . For one specific r , we find the pattern q which maximizes (resp. minimizes) this expectation over all patterns of length k .

We also prove a few exact enumeration formulae, some of which are surprising. In particular, we will obtain a very unusual 3-fold symmetry involving objects counted by Catalan numbers. (Received January 05, 2012)

1079-05-151 **Linyuan Lu** (lu@math.sc.edu), Department of Mathematics, University of South Carolina, Columbia, SC 29208, **Austin Mohr** (mohrat@mailbox.sc.edu), Department of Mathematics, University of South Carolina, Columbia, SC 29208, and **Laszlo A. Szekely*** (szekely@math.sc.edu), Department of Mathematics, University of South Carolina, Columbia, SC 29208. *Quest for negative dependency graphs.* Preliminary report.

The Lovász Local Lemma has an extension, due to Erdős and Spencer, which relaxes "dependency graph" in the condition to "negative dependency graph". Few families of negative dependency graphs are known that are not dependency graphs as well. In this talk we discuss such families and conjecture some further negative dependency graphs. (Received January 09, 2012)

1079-05-157 **Wiseley A Wong*** (wwong@math.udel.edu), Department of Mathematical Sciences, Newark, DE 19716, and **Sebastian M Cioaba** (cioaba@math.udel.edu), Department of Mathematical Sciences, Newark, DE 19716. *Edge-disjoint spanning trees and eigenvalues of regular graphs.*

Partially answering a question of Seymour, we show that if the second largest eigenvalue of a d -regular graph is at most $d - \frac{2k-1}{d+1}$, then the graph contains at least k edge-disjoint spanning trees (for $k = 2$ or 3). We construct examples of d -regular graphs that show that our eigenvalue bounds are essentially best possible. We conjecture that the above eigenvalue condition is sufficient for the existence of k edge-disjoint spanning trees for any $k < d/2$. (Received January 10, 2012)

1079-05-164 **Brigitte Servatius*** (bservat@wpi.edu), 100 Institute Rd, Worcester, MA 01609-2280. *Kinematics of Zeolites.* Preliminary report.

The kinematics of a model of interlinked tetrahedra which was described by H. HARBORTH and M. MOELLER consisting of 16 congruent regular tetrahedra connected via 32 spherical joints was recently investigated by P. FAZEKAS, O. ROESCHEL and the presenter. It was found that although the Gruebler formula gives a theoretical degree of freedom 6 for this kinematic chain, and therefore the model should be rigid, this mechanism admits at least a two-parametric self-motion in the general position. Saturated packings of tetrahedra are used to model Zeolites, which are microporous, aluminosilicate minerals. They have some interesting properties which we attempt to explain mathematically. (Received January 10, 2012)

1079-05-165 **Alex Fink*** (arfink@ncsu.edu) and **Andrew Berget**. *Orbits of projective point configurations.* Preliminary report.

Given an $r \times n$ matrix, thought of as representing n points in projective $(r-1)$ -space, we consider the closure of the orbit of all projectively equivalent matrices. I will describe the equations cutting out this variety, and their relation to the matroid of the point configuration. (Received January 10, 2012)

1079-05-169 **Matthias Beck** (mattbeck@sfsu.edu), Department of Mathematics, San Francisco State University, San Francisco, CA 94132, and **Yvonne Kemper*** (ykemper@math.ucdavis.edu), Department of Mathematics, University of California at Davis, Davis, CA 95616. *Flows on Simplicial Complexes*. Preliminary report.

Given a graph G , the number of nowhere-zero \mathbb{Z}_q -flows $\phi_G(q)$ is known to be a polynomial in q . In this talk, we extend the definition of nowhere-zero \mathbb{Z}_q -flows to simplicial complexes Δ of dimension greater than one, and prove the polynomiality of the corresponding function $\phi_\Delta(q)$ for certain q and certain subclasses of simplicial complexes. (Received January 11, 2012)

1079-05-170 **Guantao Chen*** (gchen@gsu.edu), Department of Mathematics and Statistics, Georgia State University, Atlanta, GA 30303, and **Nana Li**. *Phase Transitions in Highly Edge-Connected Graphs*. Preliminary report.

Let G be a graph with n vertices and $\mathbf{p} \in [0, 1]^{\mathcal{N}}$, where \mathcal{N} is the set of all natural numbers. In this talk we consider a *dynamic discrete percolation model*: a sequence of ordered triples (G, \mathbf{p}, t) , $t = 0, 1, 2, \dots$ such that, at any time t , $V(G)$ is partitioned into an open set O_t and a closed set C_t satisfying that initially there is exact one open vertex, an open vertex will never be close, and if $v \in C_t$, then v is open at time $t + 1$ with probability $1 - (1 - \mathbf{p}(n))^{d_{O_t}(v)}$, independently of the other vertices. In this talk, we show that for any $0 < p \leq 1$ and $0 < \alpha < 1$, there is a finite integer $T = T(p, \alpha)$, s.t. $O_T(G) = V(G)$ holds asymptotically almost surely for all graphs with edge connectivity $\kappa'(G) \geq \alpha|V(G)|$ following the (G, \mathbf{p}, t) process. Additionally, the edge-connective constraint cannot be replaced by the minimum degree condition. A more general result allowing $\lim_{n \rightarrow \infty} \mathbf{p}(n) = 0$ will be discussed. (Received January 11, 2012)

1079-05-172 **Nicholas A. Loehr*** (nloehr@vt.edu), Virginia Tech Dept. of Mathematics, 460 McBryde Hall, Blacksburg, VA 24061-0123, and **Elizabeth Niese**, Dept. of Mathematics, Marshall University, Huntington, WV 25755. *A bijective proof of a factorization formula for specialized Macdonald polynomials*.

Let μ and ν be integer partitions such that μ is obtained from ν by adding m parts of size r . Descouens and Morita proved algebraically that the modified Macdonald polynomials $\tilde{H}_\mu(X; q, t)$ satisfy the factorization $\tilde{H}_\mu = \tilde{H}_\nu \tilde{H}_{(r^m)}$ when the parameter t is specialized to a complex m 'th root of unity. We describe a bijective proof of this formula, valid when r is the smallest part of μ , based on Haglund's combinatorial formula for Macdonald polynomials. (Received January 11, 2012)

1079-05-175 **Jia Huang*** (huang338@umn.edu), 127 Vincent Hall, 206 Church ST SE, Minneapolis, MN 55455. *0-Hecke algebra actions on polynomials*.

The 0-Hecke algebra is an interesting deformation of the group algebra of the symmetric group. I will talk about its actions on the polynomial ring and certain quotient rings, and discuss some examples whose characters give the noncommutative Hall-Littlewood functions introduced by Bergeron and Zabrocki. (Received January 11, 2012)

1079-05-178 **Sarah Anderson*** (sarah5@g.clemson.edu), **Hiren Maharaj** and **Jeong-Hyun Kang**. *Distance graphs on \mathbb{Z}^n with l_1 norm*.

Let $G = (\mathbb{Z}^n, D)$ be a graph such that $x, y \in \mathbb{Z}^n$ are adjacent if and only if $\|x - y\|_{l_1} \in D$, where $D = \{r \mid 1 \leq r \leq d - 1\}$ for $1 \leq d \leq n$. We show $\chi(G) \geq \frac{2^n}{A(n, d)}$, where $A(n, d)$ denotes the maximum possible size of a binary code of length n and minimum Hamming distance d . These results can be generalized by considering $G = (\mathbb{Z}^n, D)$, where $D = \{d \mid d < d_1 \text{ or } d_2 < d \leq n\}$ for $1 \leq d_1 \leq d_2 \leq n$. We define a $(n, [d_1, d_2])$ -code to be the set $\mathcal{C} \subset \{0, 1\}^n$ such that for all $x, y \in \mathcal{C}$, $d_1 \leq d(x, y) \leq d_2$. We show $\chi(G) \geq \frac{2^n}{A(n, [d_1, d_2])}$, where $A(n, [d_1, d_2])$ denotes the maximum size of a $(n, [d_1, d_2])$ -code. We examine codes in spherical caps, $Z(n, [0, \phi])$, to find an upper bound for $A(n, [d_1, d_2])$. In fact, if $n \geq 2d_2 + 1$, then $A(n, [d_1, d_2]) \leq A_Z(n, \theta, \phi')$, where $A_Z(n, \theta, \phi')$ denotes the maximum size of a θ -code in a spherical cap, $Z(n, [0, \phi'])$, $\cos(\theta) = 1 - \frac{2d_1}{n}$, and $\cos(\phi') = \frac{\cos(\phi)}{\sqrt{1/A(n, [d_1, d_2]) + \cos(\theta)}}$, where $\cos(\phi) = 1 - \frac{2d_2}{n}$. (Received January 11, 2012)

1079-05-180 **John E Lenz*** (lenz@math.uic.edu) and **Dhruv Mubayi**. *Multicolor Ramsey Numbers for Complete Bipartite Versus Complete Graphs*. Preliminary report.

Let H_1, \dots, H_k be graphs. The multicolor Ramsey number $r(H_1, \dots, H_k)$ is the minimum integer r such that in every edge-coloring of K_r by k colors, there is a monochromatic copy of H_i in color i for some $1 \leq i \leq k$. This talk will focus on the multicolor Ramsey number $r(K_{2,t}, \dots, K_{2,t}, K_m)$; both upper and lower bounds will be discussed. Several different constructions are used for the lower bounds, including the random graph and explicit graphs built from finite fields. A technique of Alon and Rödl using the probabilistic method and spectral

arguments is employed to supply tight lower bounds. A sample result is $c_1 m^2 t / \log^4(mt) \leq r(K_{2,t}, K_{2,t}, K_m) \leq c_2 m^2 t / \log^2 m$ for some constants c_1 and c_2 . (Received January 11, 2012)

1079-05-187 **Grady Bullington** and **Linda Eroh***, eroh@uwosh.edu, and **Steven J Winters**.
Prisoners and guards on rectangular boards. Preliminary report.

Woolbright introduced the “Prisoners and Guards” game as a two-player game on an $n \times n$ checkerboard. At the beginning of the game, every square of the board has a guard. At each stage in the game, for each prisoner, there must be at least as many guards as prisoners on adjacent squares. The players take turns either replacing a guard with a prisoner in their color or replacing one prisoner (of either color) with a guard, then replacing two guards with prisoners in their color, subject to the rule above. When neither player can adjust the board any further, the player with more prisoners in their color wins. Howard, Ionascu, and Woolbright characterized the maximal and maximum configurations of $n \times n$ boards, that is, the boards for which neither player can make any moves. In this talk, we give formulas for the number of prisoners in the maximum configurations of $n \times m$ boards, where $2 \leq n < m$, for $n = 2, 3, 4$, and 5 , and provide a bound when $n = 6$. (Received January 12, 2012)

1079-05-195 **Annette Werner** and **Josephine Yu***, School of Mathematics, Georgia Tech, Atlanta, GA 30308. *Symmetric Alcovod Polytopes*.

Generalized alcoved polytopes are polytopes whose facet normals are roots in a given root system. The type A alcoved polytopes are precisely the polytopes that are tropically convex. We say that a set of points in a type- t alcoved polytope is a generating set if the polytope is the smallest one containing the set. For type A , the tropical generators form a generating set. We show that for any root system other than F_4 , every alcoved polytope invariant under the natural Weyl group action has a generating set consisting of Coxeter number of elements. (Received January 12, 2012)

1079-05-196 **Kiran B Chilakamarri***, Kchilakamarri@yahoo.com. *Unit distance graphs, Variable distance graphs, and Graphs on integer lattice*.

If a simple graph G can be drawn on the plane so that every edge is a straight line segment of length d , then G is a unit distance graph (contracting the plane we can choose $d=1$). Edges can cross in these drawings. If the length of every edge is in a closed interval $[a, b]$, then G is a variable distance graph. If we further demand that all coordinates of all vertices be integers then G is a variable distance graph on integer lattice. It is easy to see that $K(4)$, the complete graph on four vertices, is not a unit distance graph. Similarly $K(3,3)$ is not a unit distance graph if we insist that all vertices be distinct. The Petersen graph is a unit-distance graph. Characterization of unit distance graphs is a challenging unsolved problem. On the other hand any graph is a variable distance graphs if the interval $[a, b]$ is appropriately chosen. The unit distance graph problem is a famous unsolved problem and is equivalent to finding maximum of chromatic numbers of unit distance graphs. This number is known to be between 4 and 7, but the exact number is not known. I will present a number of interesting problems dealing with unit distance graphs, variable distance graphs and graphs on integer lattice graphs. (Received January 12, 2012)

1079-05-197 **Oguz Kurt***, 231 W 18th Ave, Columbus, OH 43210. *Planar 7-graphs are 7-edge-colorable*. Preliminary report.

An r -graph is an r -regular graph such that all edge-cuts separating odd subsets of the vertex set have at least r edges. As an edge-coloring generalization of 4-Color Theorem, Seymour conjectured that “Any planar r -graph is r -edge-colorable.” Guenin showed that the conjecture holds for $r = 4, 5$ and recently, Dvorak, Kawarabayashi and Kral [D-K-K] showed that it holds for $r = 6$. We show, using Discharging Method, that this conjecture holds for $r = 7$. We note here that [D-K-K] also claims to have a proof for $r = 7$. (Received January 12, 2012)

1079-05-200 **Rong Luo*** (rluo@mtsu.edu), Department of Mathematical Sciences, Middle Tennessee State University, Murfreesboro, TN. *The size of edge chromatic critical graphs*. Preliminary report.

Vizing conjectured in 1968 that for each edge chromatic critical G with maximum degree Δ , $m \geq \frac{1}{2}\{n(\Delta-1)+3\}$ where m and n is the number of edges and vertices, respectively. In this talk, we will present a new lower bound on the size of critical graphs. This is joint work with Yue Zhao. (Received January 12, 2012)

1079-05-210 **Michael Goff*** (michael.goff@vanderbilt.edu), Vanderbilt Math Department, 1326 Stevenson Center, Nashville, TN 37240. *Edge growth in graph squares*.

Peter Hegarty has posed the problem of finding lower bounds on a power of a d -regular graph. We will survey some main results and in particular show that, if G^2 is not a complete graph and is not a member of two narrow families of graphs, then G^2 has at least $2n - o_1(d)$ edges more than G . We will discuss the connection between

the graph power problem and the Cauchy-Davenport theorem and Cayley graphs, and we propose variants of the problem with stronger regularity conditions on the graph. (Received January 13, 2012)

1079-05-218 **Debra Boutin*** (dboutin@hamilton.edu). *The Cost of 2-Distinguishing.*

A graph is said to be *2-distinguishable* if there is a labeling of the vertices with two labels so that only the trivial automorphism preserves the vertex labels. Define the *cost of 2-distinguishing* G , denoted $\rho(G)$, to be the minimum size of a label class in such a labeling. A *determining set* of a graph is a subset of its vertices with the property that each automorphism of the graph is uniquely determined by its action on the set; its minimum size is denoted $\text{Det}(G)$. Determining sets can be an elegant first approximation for a label class of a 2-distinguishing labeling. Using these, this talk will examine a few classes of graphs for which $\rho(G) \in \{\text{Det}(G), \text{Det}(G) + 1\}$. These classes contain some Kneser graphs, hypercubes, and other Cartesian powers. (Received January 13, 2012)

1079-05-224 **Anthony Giaquinto, Aaron Lauve*** (lauve@math.luc.edu) and **John Versnel.** *The Spectra of Principal Elements in Frobenius Seaweed Lie Algebras.* Preliminary report.

A Lie algebra \mathfrak{L} is *Frobenius* if there exists a functional $f \in \mathfrak{L}^*$ satisfying: if $f([a, b]) = 0$ for all b , then $a = 0$. Such nondegenerate f establish an isomorphism between \mathfrak{L} and \mathfrak{L}^* . Let \widehat{f} denote the corresponding element of \mathfrak{L} . It seems that the spectrum of $\text{ad } \widehat{f}$ is an invariant of \mathfrak{L} , i.e., independent of which (nondegenerate) f is originally chosen. Even more startling, the spectrum is an unbroken string of integers of the form $(-n, -n + 1, \dots, 0, 1, \dots, n + 1)$. (One could try quoting the theory of semisimple Lie algebras as an explanation, except that Frobenius Lie algebras are not semisimple.) In this talk, we give a proof for maximal parabolic subalgebras of \mathfrak{sl}_n and outline a strategy to handle the Frobenius “seaweed Lie algebras” of Dergachev–Kirillov (2000). (Received January 14, 2012)

1079-05-226 **Nathan Ferd Williams*** (will3089@umn.edu). *Towards a uniform description of a bijection between nonnesting and noncrossing partitions.* Preliminary report.

Nonnesting and noncrossing partitions have elegant definitions: elements of the positive root poset of a crystallographic root system are the nonnesting partitions, while elements beneath a Coxeter element in the absolute order on the corresponding Coxeter group are the noncrossing partitions. There is a case-by-case proof that there are the same number of nonnesting and noncrossing partitions for each type, but a uniform statement demands a uniform proof. D. Armstrong, C. Stump, and H. Thomas recently exploited two natural cyclic actions to uniformly characterize a bijection between nonnesting and noncrossing partitions. A natural next step would be a uniform description of a bijection; we present some work in this direction. (Received January 14, 2012)

1079-05-244 **Sebastian M Cioaba*** (cioaba@math.udel.edu), University of Delaware, Department of Mathematical Sciences, Ewing Hall, Newark, DE 19716. *Disconnecting strongly regular graphs.*

A (v, k, λ, μ) -strongly regular graph is a k -regular graph such that any two adjacent vertices have exactly λ common neighbors and any two distinct non-adjacent vertices have exactly μ common neighbors. Strongly regular graphs are interesting mathematical objects with connections to combinatorics, algebra, geometry, coding theory and computer science among others.

In 1985, Brouwer and Mesner proved that the vertex-connectivity of any connected strongly regular graph equals its degree and the only disconnecting sets of minimum size are the neighborhoods of the vertices of the graph.

In 1996, Brouwer conjectured that the minimum size of a disconnecting set of vertices in a (v, k, λ, μ) -strongly regular graph whose removal yields only non-singleton components, is $2k - \lambda - 2$ (which is the size of the neighborhood of any edge).

In this talk, I will show Brouwer’s Conjecture is false in general by presenting some infinite families of counterexamples arising from copolar and Δ -spaces. I will show Brouwer’s Conjecture is true for many families of graphs including conference graphs, lattice graphs and Latin square graphs.

Joint work with Kijung Kim (Pusan National University, South Korea) and Jack Koolen (Postech, South Korea). (Received January 16, 2012)

1079-05-246 **J. Haglund*** (jhaglund@math.upenn.edu), 209 S. 33rd. St., Philadelphia, PA 19104-6395. *Formulas for the Hilbert Series of Diagonal Harmonics.* Preliminary report.

We give a survey of various known and conjectured formulas for the Hilbert Series of Diagonal Harmonics. We show how each of these formulas has a family of associated conjectures attached to them. Most of these conjectures can be expressed in terms of generalized parking functions. (Received January 16, 2012)

1079-05-247 **J. Haglund*** (jhaglund@math.upenn.edu), 209 S. 33rd St., Philadelphia, PA 19104-6395. *Plethystic Methods in the study of Diagonal Harmonics*. Preliminary report.

We show how various combinatorial formulas for the character of the space of Diagonal Harmonics can be obtained by starting with Haiman's formula for the character in terms of Macdonald polynomials and then applying plethystic symmetric function identities. (Received January 16, 2012)

1079-05-254 **Guoli Ding*** (ding@math.lsu.edu). *A chain theorem for 3^+ -connected graphs*.

A 3-connected graph is 3^+ -connected if it has no 3-separation that separates a "large" fan or $K_{3,n}$ from the rest of the graph. We show that, except for K_4 , every 3^+ -connected graph has a 3^+ -connected proper minor that is at most two edges away from the original graph. Applications of this result will also be discussed. (Received January 16, 2012)

1079-05-262 **Simon M. Smith** and **Mark E. Watkins*** (mewatkin@syr.edu), Syracuse University, Mathematics Department, 215 Carnegie, Syracuse, NY 13244-1150. *Finite subgraphs of d -distinguishable, locally finite graphs*. Preliminary report.

It is known (M.E. Watkins and X. Zhou, 2007) that every infinite, locally finite tree T with finite distinguishing number $d(T) = d_0$ contains a finite subtree with distinguishing number d_0 . It is not difficult to prove more generally that if every finite subgraph Φ of an infinite, locally finite graph Γ satisfies $d(\Phi) \leq d_0$, then $d(\Gamma) \leq d_0 + 1$. We investigate conditions subject to which this bound may be sharp. (Received January 16, 2012)

1079-05-270 **Matthew Kahle*** (mkahle@math.osu.edu). *Configuration spaces of hard spheres*.

I will discuss recent progress on understanding configuration spaces of hard spheres in a bounded region. This is motivated by classical problems in statistical mechanics, but leads to many interesting new questions in topology, geometry, and combinatorics.

I will report on recent work which applies Morse theory to understand the topology of these spaces. Some of this is joint with Yuliy Baryshnikov & Peter Bubenik, and some with Robert MacPherson. (Received January 16, 2012)

1079-05-277 **John Maharry*** (maharry@math.ohio-state.edu) and **Neil Robertson**. *Topological Ideals and Well-Quasi Orders*.

In 1986, Neil Robertson conjectured that a graph ideal J closed under topological inclusion is a well-quasi order if and only if J includes only finitely many doubled circuits and doubled rooted paths. These two families of graphs, doubled circuits $2C_k$ and doubled rooted paths $2P_k$, form an antichain under topological inclusion. In this talk we discuss the first steps toward proving this conjecture and give a possible roadmap for the complete proof. (Received January 16, 2012)

1079-05-283 **György Turán*** (gyt@uic.edu), University of Illinois at Chicago, Dept. of Math., Stat. and Comp. Sci., Chicago, IL 60607. *On directed hypergraphs*. Preliminary report.

We consider directed 3-uniform hypergraphs with edges of the form $a, b \rightarrow c$, where a, b is the body and c is the head of the edge. An exact solution is presented for the following problem: what is the maximal number of edges in an n -vertex hypergraph without two edges $a, b \rightarrow c$ and $c, d \rightarrow e$? We also discuss a class of reachability problems for directed hypergraphs, where reachability is defined by the forward chaining procedure. The *hydra number* of an undirected graph G is the minimal number of hyperedges with bodies in $E(G)$ such that forward chaining started from any edge of G reaches all vertices. Various results are given on hydra numbers such as a characterization of trees with low hydra number, and bounds for the hydra numbers of complete binary trees. These problems are motivated by problems for Horn formulas in propositional logic.

Joint work with Marina Langlois, Dhruv Mubayi, Robert Sloan and Despina Stasi. (Received January 16, 2012)

1079-05-285 **Amin Bahmanian*** (mzb0004@auburn.edu), 221 Parker Hall Dept. of Math. and Stat., Auburn University, Auburn, AL 36849. *Connected Baranyai's Theorem*.

Let $K_n^h = (V, \binom{V}{h})$ be the complete h -uniform hypergraph on vertex set V with $|V| = n$. Baranyai showed that K_n^h can be expressed as the union of edge-disjoint r -regular factors if and only if h divides rn and r divides $\binom{n-1}{h-1}$. We prove that λK_n^h can be expressed as the union $\mathcal{G}_1 \cup \dots \cup \mathcal{G}_k$ of k edge-disjoint factors, where for $1 \leq i \leq k$, \mathcal{G}_i is r_i -regular if and only if (i) h divides $r_i n$ for $1 \leq i \leq k$, (ii) $\sum_{i=1}^k r_i = \lambda \binom{n-1}{h-1}$. Moreover, for $1 \leq i \leq k$, if $r_i \geq 2$, we can guarantee that \mathcal{G}_i is connected, generalizing Baranyai's theorem, and answering a questions by Katona. (Received January 17, 2012)

1079-05-290 **Jingfen Lan** and **Linyuan Lu*** (lu@math.sc.edu), Columbia, SC 29208. *Diameters of Graphs with Spectral Radius at most $\frac{3}{2}\sqrt{2}$.*

The spectral radius $\rho(G)$ of a graph G is the largest eigenvalue of its adjacency matrix. Woo and Neumaier discovered that a connected graph G with $\rho(G) \leq 3/2\sqrt{2}$ is either a dagger, an open quipu, or a closed quipu. In this paper, we proved the following results. For any open quipu G on n vertices ($n \geq 6$) with spectral radius less than $3/2\sqrt{2}$, its diameter $D(G)$ satisfies $D(G) \geq (2n-4)/3$. This bound is tight. For any closed quipu G on n vertices ($n \geq 13$) with spectral radius less than $3/2\sqrt{2}$, its diameter $D(G)$ satisfies $\frac{n}{3} < D(G) \leq \frac{2n-2}{3}$. The upper bound is tight while the lower bound is asymptotically tight. Let $G_{n,D}^{min}$ be a graph with minimal spectral radius among all connected graphs on n vertices with diameter D . For $n \geq 13$ and $D \in [\frac{n}{2}, \frac{2n-7}{3}]$, we proved that $G_{n,D}^{min}$ is the graph obtained by attaching two paths of length $D - \lfloor \frac{n}{2} \rfloor$ and $D - \lceil \frac{n}{2} \rceil$ to a pair of antipodal vertices of the even cycle $C_{2(n-D)}$. Thus we settled a conjecture of Cioab-van Dam-Koolen-Lee, who previously proved a special case $D = \frac{n+e}{2}$ for $e = 1, 2, 3, 4$. (Received January 17, 2012)

1079-05-295 **Xiaoya Zha*** (xzha@mtsu.edu), Department of Mathematical Sciences, Middle Tennessee State University, Murfreesboro, TN 37132. *Maximum connectivity and genus connectivity of surfaces.*

It is well known that planar graphs can be at most 5-connected and toroidal graphs can be at most 6-connected. Cooke obtained an upper bound on the possible connectivity of a graph embedded in any given surface (orientable or non-orientable). Results from map color theory (the genera of complete graphs) show that this upper bound is attained by a complete graph. This tight upper bound is called the *maximum connectivity* of a surface. This leads to two natural questions. (1) For each surface, is the complete graph that attains the maximum connectivity the unique graph embeddable on that surface with that connectivity? (2) For many surfaces, the complete graph that attains the maximum connectivity in fact has a lower genus. So, for each surface one may ask for the maximum connectivity among graphs with genus embeddings in that surface (called the *genus connectivity* of the surface). It is interesting that the genus connectivity does not increase monotonically with genus, while maximum connectivity does. In this talk we will discuss the status of work on these two questions. (Received January 17, 2012)

1079-05-297 **Linyuan Lu** (lu@math.sc.edu), Columbia, SC 29208, and **Xing Peng*** (pengx@mailbox.sc.edu), Columbia, SC 29208. *Loose Laplacian spectra of random hypergraphs.*

Let $H = (V, E)$ be an r -uniform hypergraph with the vertex set V and the edge set E . For $1 \leq s \leq r/2$, we define a weighted graph $G^{(s)}$ on the vertex set $\binom{V}{s}$ as follows. Every pair of s -sets I and J is associated with a weight $w(I, J)$, which is the number of edges in H containing I and J if $I \cap J = \emptyset$, and 0 if $I \cap J \neq \emptyset$. The s -th Laplacian $\mathcal{L}^{(s)}$ of H is defined to be the normalized Laplacian of $G^{(s)}$. For $0 < p < 1$, let $H^r(n, p)$ be a random r -uniform hypergraph over $[n] := \{1, 2, \dots, n\}$, where each r -set of $[n]$ has probability p to be an edge independently. We prove the eigenvalues of $\mathcal{L}^{(s)}(H^r(n, p))$ can be approximated by those of the expectation hypergraph. Moreover, we show the distribution of eigenvalues of $\mathcal{L}^{(s)}(H^r(n, p))$ follows the Semicircle Law. (Received January 17, 2012)

1079-05-306 **M. N. Ellingham** and **Justin Z. Schroeder*** (justin.z.schroeder@vanderbilt.edu). *Nonorientable hamilton cycle embeddings of complete tripartite graphs.*

A cyclic construction is presented for building embeddings of the complete tripartite graph $K_{n,n,n}$ on a nonorientable surface such that the boundary of every face is a hamilton cycle. This construction works for several families of values of n , and we extend the result to all n with some methods of Bouchet and others. The nonorientable genus of $K_{t,n,n,n}$, for $t \geq 2n$, is then determined using these embeddings and a surgical method called the 'diamond sum' technique. (Received January 17, 2012)

1079-05-310 **Younjin Kim*** (kyounjin@msri.org), MSRI, 17 Gauss Way, Berkeley, CA 94720, and **Janos Barat** (janos.barat@monash.edu), **Zoltan Furedi** (z-furedi@illinois.edu), **Ida Kantor** (ida@kam.mff.cuni.cz) and **Balazs Patkos** (patkos@renyi.hu). *Large B_d -free and union-free subfamilies.*

For a property Γ and a family of sets \mathcal{F} , let $f(\mathcal{F}, \Gamma)$ be the size of the largest subfamily of \mathcal{F} having property Γ . For a positive integer m , let $f(m, \Gamma)$ be the minimum of $f(\mathcal{F}, \Gamma)$ over all families of size m . A family \mathcal{F} is said to be B_d -free if it has no subfamily $\mathcal{F}' = \{F_I : I \subseteq [d]\}$ of 2^d distinct sets such that for every $I, J \subseteq [d]$, both $F_I \cup F_J = F_{I \cup J}$ and $F_I \cap F_J = F_{I \cap J}$ hold. A family \mathcal{F} is a -union-free if $F_1 \cup \dots \cup F_a \neq F_{a+1}$ whenever F_1, \dots, F_{a+1} are distinct sets in \mathcal{F} . We verify a conjecture of Erdős and Shelah that $f(m, B_2\text{-free}) = \Theta(m^{2/3})$. We also obtain lower and upper bounds for $f(m, B_d\text{-free})$ and $f(m, a\text{-union free})$. (Received January 18, 2012)

1079-05-312 **Qiuli Li*** (qiulili@princeton.edu), Princeton, NJ 08544, and **Heping Zhang**. *On the restricted matching extension of graphs in surfaces*. Preliminary report.

A connected graph G with at least $2m + 2n + 2$ vertices is said to have property $E(m, n)$ if for any two disjoint matchings M and N of size m and n respectively, G has a perfect matching F such that $M \subseteq F$ and $N \cap F = \emptyset$. Let $\mu(\Sigma)$ be the smallest integer k such that no graphs embedded in the surface Σ are k -extendable. It has been showed that no graphs embedded in some scattered surfaces as the sphere, projective plane, torus and Klein bottle are $E(\mu(\Sigma) - 1, 1)$. In this paper, we show that this result holds for all surfaces. Furthermore, we obtain that for each integer $k \geq 4$, if a graph G embedded in a surface has enough many vertices, then G doesn't have property $E(k - 1, 1)$. (Received January 17, 2012)

1079-05-313 **Zdenek Dvorak, Bernard Lidicky, Bojan Mohar and Luke Postle*** (ljpostle@math.gatech.edu). *5-list-coloring planar graphs with distant precolored vertices*. Preliminary report.

We prove the conjecture of Albertson stating that every planar graph can be 5-list-colored, even if it contains precolored vertices which are sufficiently far apart. In order to prove this claim, we also give bounds on the sizes of graphs critical with respect to 5-list coloring. In particular, if G is a planar graph, H is a connected subgraph of G and L is an assignment of lists to the vertices of G such that $|L(v)| \geq 5$ for every $v \in V(G) \setminus V(H)$ and G is not L -colorable, then G contains a subgraph with $O(|H|^2)$ vertices that is not L -colorable. (Received January 17, 2012)

1079-05-317 **Karen L. Collins*** (kcollins@wesleyan.edu), Dept. of Mathematics and Computer Science, Middletown, CT 06459, and **Ann Trenk** (atrenk@wellesley.edu), Dept. of Mathematics, Wellesley, MA. *Distinguishing chromatic bounds like Nordhaus-Gaddum*.

Albertson and Collins defined the distinguishing number of graph as the minimum number of colors needed to color the vertices of so that only the trivial automorphism preserves the colors. Collins and Trenk defined the distinguishing chromatic number to be the minimum number of colors needed for a labeling which is both proper and distinguishing. We will generalize the classic Nordhaus-Gaddum theorem for the chromatic number, namely that for G a graph,

$$\chi(G) + \chi(\overline{G}) \leq |V(G)| + 1$$

to the distinguishing chromatic number and provide a new characterization of graphs that achieve equality in the above bound. (Received January 17, 2012)

1079-05-321 **Constance G. Baltera*** (cgb2k@virginia.edu) and **Weiqiang Wang**. *Spin Coinvariant Algebras and Spin Fake Degrees for Weyl Groups*.

For an irreducible representation of a Weyl group, the fake degree is its graded multiplicity in the coinvariant algebra. We formulate a notion of a spin coinvariant algebra for a distinguished double cover of every Weyl group, and compute the graded multiplicities of the irreducible spin representations in this algebra, which are called the spin fake degrees. (Received January 17, 2012)

1079-05-327 **Marius M Somodi*** (marius.somodi@uni.edu), Department of Mathematics, University of Northern Iowa, Cedar Falls, IA 50614. *Arithmetical Equivalence of Graph Coverings*.

We begin by introducing the concept of arithmetical equivalence of graph coverings, inspired from a similar concept from number theory. Then we discuss different characterization of arithmetical equivalence of graph coverings and investigate the connection with the Ihara zeta function. (Received January 17, 2012)

1079-05-332 **Zixia Song*** (Zixia.Song@ucf.edu) and **Evan Weiss**, Department of Mathematics, University of Central Florida. *Odd Clique Minors in Graphs with Independence Number Two*.

Let G be a graph on n vertices with independence number two. We prove that G contains an odd clique minor of size at least $\frac{n}{2}$ if G does not contain certain small graph as an induced subgraph. (Received January 17, 2012)

1079-05-337 **Christian Joseph Altomare*** (altomare@math.ohio-state.edu), 281 Franklin Avenue, Worthington, OH 43085. *On Structural Descriptions of Lower Ideals of Series Parallel Graphs and Posets*.

Robertson, Seymour, and Thomas sought to obtain a structure theorem for an arbitrary topological minor closed family of trees. Building on their work, Nigussie gave an algorithm to calculate such structure theorems. Nigussie's algorithm is efficient enough that specific structure theorems can be calculated quickly by hand.

The eventual goal of this line of research is to calculate a structure theorem for an arbitrary minor closed family of finite graphs. Even getting specific structure theorems is difficult, so the general problem is wide open. Since trees are the graphs of tree width at most 1, the tree width at most 2 case is a natural stepping stone. For the purpose of obtaining structure theorems, the study of tree width at most 2 is essentially the study of series parallel graphs.

Trees are both graphs and posets. We believe the theorems proved for trees thus far are best seen as poset theorems, and we thus work instead with series parallel posets. The speaker has obtained an efficient, Nigussie type algorithm for series parallel posets under the suborder relation. We present this result and how it relates to finding structure theorems for series parallel graphs under the minor relation. (Received January 17, 2012)

1079-05-340 **Vaidy Sivaraman*** (vaidy@math.ohio-state.edu), **John Maharry**, **Neil Robertson** and **Daniel Slilaty**. *Flexibility of projective-planar graphs.*

We give a set of operations that completely accounts for the flexibility of non-planar graphs on the projective plane. Understanding the flexibility of graphs on the projective plane sheds light on the signed-graphic matroid isomorphism problem in the regular case. Also, the result has several interesting corollaries, one of which states that if a 3-connected graph has a 4-representative embedding in the projective plane, then that is the only embedding of the graph in the projective plane. (Received January 17, 2012)

1079-05-343 **Katie V. Johnson*** (s-kfield1@math.unl.edu), 203 Avery Hall, Lincoln, NE 68588. *Linear Extension Diameter: how much could we possibly disagree?*

A linear extension of a partially ordered set P is simply a total ordering of the poset that is consistent with the original ordering. The linear extension diameter is a measure of how different two linear extensions could be, that is, the number of pairs of elements of P that are ordered differently by the two extensions. I will consider the linear extension diameter of grids, generalizing a method of focusing on sub-cubes that was developed in a 2011 paper by Felsner and Massow. This process also gives us a nice characterization of the linear extensions that are the farthest from each other. (Received January 17, 2012)

1079-05-347 **Jie Han*** (jhan22@student.gsu.edu), Department of Mathematics and Statistics, Georgia State University, Atlanta, GA 30303, and **Yi Zhao** (yzhao6@gsu.edu), Department of Mathematics and Statistics, Georgia State University, Atlanta, GA 30303. *Absorbing lemma for the multipartite Hajnal-Szemerédi Theorem.*

Let G be a k -partite graph with n vertices in each part such that each vertex is adjacent to at least $\bar{\delta}(G)$ vertices in each of the other parts. Magyar and Martin proved that for $k = 3$, if $\bar{\delta}(G) \geq \frac{2}{3}n + 1$ and n is sufficiently large, then G contains a K_3 -factor (a spanning subgraph consisting of n vertex-disjoint copies of K_3). Martin and Szemerédi proved that the conclusion holds for $k = 4$ when $\bar{\delta}(G) \geq \frac{3}{4}n$ and n is sufficiently large. Both results were proved by the Regularity Lemma. Keevash and Mycroft recently used a geometric approach to show that $\bar{\delta}(G) \geq \frac{k-1}{k}n + o(n)$ guarantees a K_k -factor for all $k \geq 2$. In this talk we give a proof of these results by the absorbing method. (Received January 18, 2012)

1079-05-351 **Thomas Dinitz**, **Matthew Hartman** and **Jenya Soprunova*** (soprunova@math.kent.edu), E. Summit st., Kent, OH 44242. *Tropical determinant on the Birkhoff polytope.*

We start with the following combinatorial problem: Given a Rubik's cube, solve it by peeling off and replacing the stickers. How many stickers would you need to peel off and replace in the worst case scenario?

This problem, translated into the language of matrices, generalizes to the following question: Given positive integers m and n , find the sharp lower bound $L(m, n)$ on the tropical determinant of integer doubly-stochastic n by n matrices whose row and column sums are equal to m . Hence the initial problem boils down to minimizing the tropical determinant over the integer points of the Birkhoff polytope. We provide a complete solution to this problem. The question that we answer can also be interpreted as an integer tropical version of the van der Waerden conjecture about permanents. (Received January 17, 2012)

1079-05-355 **Eva Czabarka*** (czabarka@math.sc.edu). *Phylogenetic trees and cyclic permutations.* Preliminary report.

A phylogenetic tree is a leaf-labeled tree with internal vertices having degree at least three (binary if the degrees are three). A drawing of a phylogenetic tree induces a cyclic permutation (by, say, a clockwise ordering of the leaves around the drawing). I am aware of two papers in the literature (by Steel and Semple, *Advances in Applied Mathematics* 2004 by Steel and Szekely, *Appl Math Lett.* 2009) that connects phylogenetic trees with cyclic permutations. A cyclic permutation of a tree excludes some quartet splits. A quartet split is a binary tree induces by 4 leaves. Any cyclic ordering of 4 labels exclude one of the three possible quartet splits on

these leaves. There are several data sets that allow for several trees consistent with a given information, and there is need for these trees to be encoded in a concise way. We have made the first steps towards using cyclic permutations to encode trees and sets of trees; e.g. we can show that a binary tree can be determined from two permutations corresponding to two of its drawings. (Received January 17, 2012)

1079-05-365 **Jeff Cooper*** (jcoope8@uic.edu). *Counting Independent Sets in Triangle-Free Graphs.* Ajtai, Komlós, and Szemerédi proved that for sufficiently large t every triangle-free graph with n vertices and average degree t has an independent set of size at least $\frac{n}{100t} \log t$. We extend this by proving that the number of independent sets in such a graph is at least

$$2^{\frac{1}{2400} \frac{n}{t} \log^2 t}.$$

This result is sharp for infinitely many t, n apart from the constant. This is joint work with Dhruv Mubayi. (Received January 18, 2012)

1079-05-367 **Xiang-dong Hou** (xhou@usf.edu), Department of Mathematics and Statistics, University of South Florida, 4202 E Fowler Ave, PHY 355, Tampa, FL 33620, and **Neranga Fernando*** (nerangafernando@yahoo.com), Department of Mathematics and Statistics, University of South Florida, 4202 E Fowler Ave, PHY 114, Tampa, FL 33620. *Permutation polynomials over finite fields defined by functional equations.* Preliminary report.

Let p be a prime and $q = p^e$. The polynomial $g_{n,q} \in \mathbb{F}_p[x]$ defined by the functional equation $\sum_{a \in \mathbb{F}_q} (x+a)^n = g_{n,q}(x^q - x)$ gives rise to many permutation polynomials over finite fields. We are interested in triples $(n, e; q)$ for which $g_{n,q}$ is a permutation polynomial of \mathbb{F}_{q^e} . We present some families of such desirable triples $(n, e; q)$ with $n = \alpha(q^{0e} + q^{1e} + \dots + q^{(p-1)e}) + \beta$, $\alpha, \beta \in \mathbb{Z}$. We also update the list of all desirable triples $(n, e; q)$ with $q = 3$ and $e \leq 6$ that have been theoretically explained. (Received January 18, 2012)

1079-05-368 **D. Christopher Stephens*** (chris.stephens@mtsu.edu). *Knots and torus graphs.* We investigate the relationship between 2-dimensional and 3-dimensional embeddings of graphs. (Received January 18, 2012)

1079-05-376 **József Balogh, Tom Bohman, Béla Bollobás and Yi Zhao*** (yzhao6@gsu.edu). *Turán densities of hypergraphs related to K_{k+1}^k .*

Let $B_i^{(k)}$ be the k -uniform hypergraph on the vertex set $S \cup T$ with $|S| = i$ and $|T| = k - 1$ whose edge set consists of all k -sets containing S or T . We derive upper and lower bounds for the Turán density of $B_i^{(k)}$ that are close to each other as $k \rightarrow \infty$. We also obtain asymptotically tight bounds for the Turán density of other infinity families of hypergraphs. The construction that supports the lower bounds is derived from elementary number theory by probabilistic arguments. To prove the upper bounds, we apply the results of de Caen, Sidorenko, and Keevash on Turán densities. (Received January 18, 2012)

1079-05-380 **Nathaniel Dean*** (nd17@txstate.edu), Department of Mathematics, 601 University Drive, San Marcos, TX 78666, and **Jonathan Berry, Bob Carr, Jill A Cochran, Susan Morey, Cynthia A Phillips and Brigitte Servatius.** *Small Unit Distance Graphs.* Preliminary report.

A graph is a unit distance graph if it can be drawn in the plane so that the distance between any pair of adjacent vertices equals one. A unit distance graph is maximal if the addition of any edge results in a graph which is not a unit distance graph. Let $u(n)$ and $U(n)$ denote the minimum and maximum number of edges in a maximal unit-distance graph of order n . Based on the asymptotic results of Erdős (1946) and Spencer, Szemerédi and Trotter (1984), finding a formula for $u(n)$ and $U(n)$ seems difficult, and further very little is known even for small n . The exact values are known for $n \leq 7$. We show through proofs and computing (i.e., graph theory, algebraic geometry, combinatorics, optimization, etc.) that $u(8) = 12$, $U(8) = 14$, and we determine all maximal unit distance graphs of order eight. (Received January 18, 2012)

1079-05-381 **Thomas W Tucker*** (ttucker@colgate.edu), Colgate University, Hamilton, NY 13346. *The clique number of a graph with dihedral vertex stabilizers.*

Call the action of the dihedral group D_n on the vertices of a regular n -gon, $n > 2$, *naturally dihedral*. We prove the following:

Theorem Let A be a subgroup of the automorphism group of a finite, connected graph G . Suppose that for each vertex v , the action of the stabilizer A_v on the edges incident to v is naturally dihedral. Then the clique number of G is 2, 3, 4 or 6.

The proof is short and involves the idea of angle measure at a vertex, based on the natural dihedral action. One of the many consequences is the classic result that the complete graph K_n underlies a regular (reflexible) map only for $n = 2, 3, 4, 6$. We also show for each $n = 2, 3, 4, 6$, there are infinitely many regular (reflexible) maps with clique number n . (Received January 18, 2012)

1079-05-387 **Louis DeBiasio*** (debiasld@muohio.edu) and **Tao Jiang**. *Exact codegree condition for the Fano plane via digraphs.*

Let $\text{ex}_2(n, H)$ denote the maximum codegree of a 3-graph on n vertices which does not contain a copy of H . Mubayi proved that the codegree density of the Fano plane, \mathbf{F} , is $\frac{1}{2}$ and conjectured that the exact value is $\text{ex}_2(n, \mathbf{F}) = \lfloor \frac{n}{2} \rfloor$. Using a very sophisticated “quasi-randomness” argument, Keevash proved Mubayi’s conjecture. Here we give a simple proof of Mubayi’s conjecture by using an interesting class of 3-graphs that we call “rings” – which are obtained via an auxiliary digraph. We then determine the Turán density of this family of rings. (Received January 18, 2012)

1079-05-392 **Suil O** and **Gexin Yu*** (gyu@wm.edu), Department of Mathematics, College of William and Mary. *Path cover number of 4-regular graphs.*

A path cover of a graph is a set of disjoint paths so that every vertex in the graph is contained in one of the paths. The path cover number $p(G)$ of graph G is the number of path in a path cover with minimum number of paths. We prove that an 4-regular n -vertex graph G has $p(G) \leq (n+5)/8$. This result also confirms a Graffiti.pc conjecture for 4-regular graphs. (Received January 18, 2012)

1079-05-394 **Dan Roberts*** (dpr0003@auburn.edu) and **Dean Hoffman**. *Embedding star designs.* Preliminary report.

A k -star is the complete bipartite graph $K_{1,k}$. A k -star decomposition of K_n is a partition of the edges of K_n into k -stars. We discuss embedding a partial k -star decomposition of K_n into a k -star decomposition of K_{n+t} . (Received January 18, 2012)

1079-05-398 **Joshua N Cooper*** (cooper@math.sc.edu), 1523 Greene St., LeConte College, USC, Columbia, SC 29208, and **Anna Kirkpatrick**. *Critical Sets for Graph Coloring.* Preliminary report.

Recently, Civario, McGuire, and Tugemann surprised the mathematics-of-Sudoku community by announcing a (computer-assisted) proof that a fair puzzle must have at least 17 givens (a.k.a. clues). One may interpret this as a result about “critical sets” for proper vertex colorings of the “Sudoku graph” Sud . In particular, given a coloring c of a graph G , we say that $S \subseteq V(G)$ is “determining” for c if the only proper vertex coloring extending $c|_S$ to all of $V(G)$ is c itself; S is said to be “critical” if it is determining and minimally so. Given a coloring c of G , we may define $\text{scs}(G, c)$ to be the size of the smallest critical set and $\text{lcs}(G, c)$ to be the size of the largest; then $\underline{*}(G)$ is the smallest value of $*(G)$ and $\overline{*}(G)$ is the largest value of $*(G)$ over all proper vertex colorings c of G , where $*$ = scs or lcs . Then the aforementioned result is the statement that $\underline{\text{scs}}(\text{Sud}) = 17$. Furthermore, previous work on critical sets for Latin squares has shed some light on the values of these four parameters for $K_n \square K_n$.

We discuss the matter of computing these parameters for several graph classes. Open questions abound, and we give several directions for future work. (Received January 18, 2012)

1079-05-399 **Axel Brandt** (brandtat@muohio.edu) and **Tao Jiang*** (jiangt@muohio.edu), Dept. of Math, Miami University, Oxford, OH 45056. *Turan numbers of expanded hypergraphs.* Preliminary report.

Given an r -graph H , the Turán number $\text{ex}(n, H)$ is the largest number of edges in an n -vertex r -graph not containing H as a subgraph. Let F be an r -graph on t vertices, let \mathcal{H}_ℓ^F be the family of r -graphs obtained as follows: label the vertices as v_1, \dots, v_t , add $\ell - t$ new vertices v_{t+1}, \dots, v_ℓ , then for every pair v_i, v_j not covered by an edge of F add edge $\{v_i, v_j\} \cup D_{i,j}$ through a set $D_{i,j}$ of $r - 2$ new vertices (where the sets $D_{i,j}$ are not necessarily disjoint for different $\{i, j\}$). We denote the unique member of \mathcal{H}_ℓ^F in which the sets $D_{i,j}$ are pairwise disjoint by H_ℓ^F . Several results on $\text{ex}(n, \mathcal{H}_\ell^F)$ or $\text{ex}(n, H_\ell^F)$ were obtained by Frankl-Füredi, Goldwasser, Mubayi, Mubayi-Pikhurko, Sidorenko, and other authors. We obtain some new results down this line, some of which generalize or strengthen some of the old results. (Received January 18, 2012)

1079-05-404 **YUQING CHEN*** (yuqing.chen@wright.edu), 3640 Colonel Glenn Hwy, Dayton, OH 45435. *Partial difference sets and amorphic group schemes from pseudo-quadratic bent functions.*

We present new abelian partial difference sets and amorphic group schemes of both Latin square type and negative Latin square type in certain abelian p -groups. Our method is to construct what we call pseudo-quadratic bent functions and use them in place of quadratic forms. We also discuss a connection between strongly regular bent functions and amorphic group schemes. This is a joint work with John Polhill. (Received January 18, 2012)

1079-05-406 **hoda bidkhorī*** (bidkhorī@mit.edu), Massachusetts Institute of Technology, Cambridge, MA 02139. *Lattice Path Matroid Polytopes.*

Fix two lattice paths P and Q from $(0, 0)$ to (m, r) that use East and North steps with P never going above Q . Bonin et al. show that the lattice paths that go from $(0, 0)$ to (m, r) and remain bounded by P and Q can be identified with the bases of a particular type of transversal matroid, which we call it a lattice path matroid.

In this paper, we consider properties of the lattice path matroid polytopes. These are the polytopes associated to the lattice path matroids. We investigate their face structure, decomposition, triangulation, Ehrhart polynomial and volume. We also briefly look over Ehrhart polynomial of Alcovod polytopes as well as the Eulerian-Catalan numbers which are closely related. (Received January 18, 2012)

1079-05-410 **Jorge Bruno** (rockhardar@gmail.com), Galway, Ireland, and **Edwin O'Shea*** (osheaem@jmu.edu), Harrisonburg, VA 22807. *Relaxed r -complete partitions: an error-correcting Bachet's problem.*

Long misnomered as Bachet's problem, a problem of Fibonacci asks: "What is the least number of pound weights that can be used on a scale pan to weigh any integral number of pounds from 1 to 40 inclusive, if the weights can be placed in either of the scale pans?" Motivated by a natural error-correcting generalization of this problem, we define, classify and enumerate *relaxed r -complete partitions*. We show that these partitions enjoy a succinct description in terms of lattice points in polyhedra, with allowances in the error being commensurate with translations in the defining hyperplanes. The enumeration of the minimal such partitions (those with fewest possible parts) can be achieved by Brion's formula for encoding lattice points in polyhedra. This work generalizes that of Rødseth on enumerating minimal r -complete partitions. (Received January 18, 2012)

1079-05-418 **Daniela Genova*** (d.genova@unf.edu), University of North Florida, Department of Mathematics and Statistics, Jacksonville, FL 32224. *Forbidding and Enforcing Systems on Graphs.*

A forbidding and enforcing system (fe-system) on graphs is a tool that defines classes of graphs based on two sets of constraints imposed on the subgraphs. A forbidding set disallows certain combinations of subgraphs in a graph, while allowing parts of these combinations to be present. An enforcing set of constraints ensures that if certain subgraphs appear in a graph, they are embedded in some larger subgraphs from a pre-specified set. Together, a forbidding set and an enforcing set form an fe-system which defines a class of graphs, such that each graph in the class conforms to both sets of constraints. This talk will present characterizations of familiar classes of graphs such as cycles, bipartite, regular, and Eulerian by fe-systems and discuss solutions to combinatorial problems, e.g. the k -colorability problem defined by fe-systems. Since fe-systems can define structures through the local character of their substructures, regardless of whether the substructures are periodic or aperiodic, they exhibit a potential to model a wide variety of biomolecular, crystal, and quasi-crystalline structures. (Received January 18, 2012)

1079-05-435 **Jerrold R. Griggs*** (griggs@math.sc.edu), Department of Mathematics, University of South Carolina, Columbia, SC 29208, and **Wei-Tian Li**. *The Lubell function of a family of subsets.* Preliminary report.

Let F be a family of subsets of the set $[n] = \{1, \dots, n\}$. The Lubell function of F is the expected number of times a random full (maximal) chain of subsets of $[n]$ intersects F . Using the Lubell function is sometimes very useful for obtaining information about $|F|$, particularly when F is a family with a forbidden subposet. We present new applications of this approach. (Received January 18, 2012)

1079-05-439 **Joseph R Chaffee*** (chaffjr@auburn.edu) and **Chris Rodger**. *K_3 -decompositions of $K(m, n, \lambda_1, \lambda_2)$.*

Let $K(m, n, \lambda_1, \lambda_2)$ be a graph with two parts, M and N , with $|M| = m$ and $|N| = n$. For each pair of vertices, there are λ_1 edges between them if they are in the same part and λ_2 edges between them otherwise. We discuss necessary and sufficient conditions for a K_3 -decomposition of $K(m, n, \lambda_1, \lambda_2)$. (Received January 18, 2012)

11 ► Number theory

1079-11-20 **Ricardo Conceicao*** (rconcei@emory.edu), Oxford College of Emory University, 100 Hamil st, Oxford, GA 30054, and **Herivelto Borges**, USP - Sao Carlos, Sau Paulo. Brazil. *On the characterization of minimal value set polynomials.*

Let q be a power of a prime, and for any non-constant polynomial $F \in \mathbb{F}_q[x]$, let $V_F = \{F(\alpha) : \alpha \in \mathbb{F}_q\}$ be its value set. One can easily show that V_F satisfies

$$\left\lfloor \frac{q-1}{\deg F} \right\rfloor + 1 \leq |V_F| \leq q, \quad (1)$$

where $\lfloor n \rfloor$ is the greatest integer $\leq n$, and $|\mathcal{S}|$ denotes the cardinality of the set \mathcal{S} . Polynomials attaining the lower bound in (1) are called minimal value set polynomials (shortened to m.v.s.p.).

In this talk we discuss some recent results related to the characterization of m.v.s.p.'s. We present a classification of all minimal value set polynomials in $\mathbb{F}_q[x]$ whose set of values is a subfield $\mathbb{F}_{q'}$ of \mathbb{F}_q . Our approach not only provides the exact number of such polynomials, but also allow us to construct many new examples of m.v.s.p.'s, derive a non-trivial lower bound for the number of m.v.s.p.'s with a fixed set of values and give a (conjectural) procedure to obtain all m.v.s.p.'s over \mathbb{F}_q . (Received October 25, 2011)

1079-11-28 **Andreas Nickel*** (andreas.nickel@mathematik.uni-regensburg.de), Universitaet Regensburg, Fakultae fuer Mathematik, Universitaetsstr. 31, 93053 Regensburg, Germany. *On the non-abelian Brumer-Stark conjecture.*

For abelian Galois CM-extensions of number fields the Brumer-Stark conjecture and Brumer's conjecture have been studied rather extensively. We recall their generalizations to arbitrary CM-extensions and show, how these conjectures may be deduced from the conjectural vanishing of certain μ -invariants under certain hypotheses. In particular, we show that these hypotheses are fulfilled outside the 2-primary part if the ground field is \mathbb{Q} . (Received November 18, 2011)

1079-11-64 **Alessandro Cobbe*** (a.cobbe@sns.it), Scuola Normale Superiore, piazza dei Cavalieri 7, 56126 Pisa, Italy, and **Luca Caputo** (luca.caputo@unilim.fr), Faculté de Sciences et Techniques, 123 Avenue Albert Thomas, 87060 Limoges, France. *An explicit candidate for the set of Steinitz classes of tame Galois extensions with fixed Galois group of odd order.*

Given a finite group G and a number field k , a well-known conjecture asserts that the set $R_t(k, G)$ of Steinitz classes of tame G -Galois extensions of k is a subgroup of the ideal class group of k . In this paper we investigate an explicit candidate for $R_t(k, G)$, when G is of odd order. More precisely, we define a subgroup $\mathcal{W}(k, G)$ of the class group of k and we prove that $R_t(k, G) \subseteq \mathcal{W}(k, G)$. We show that equality holds for all groups of odd order for which a description of $R_t(k, G)$ is known so far. Furthermore, by refining techniques introduced in [?], we use the Shafarevich-Weil Theorem in cohomological class field theory, to construct some tame Galois extensions with given Steinitz class. In particular, this allows us to prove the equality $R_t(k, G) = \mathcal{W}(k, G)$ when G is a group of order dividing ℓ^4 , where ℓ is an odd prime. (Received December 14, 2011)

1079-11-102 **G Griffith Elder*** (elder@unomaha.edu), Department of Mathematics, University of Nebraska at Omaha, Omaha, NE 68182-0243. *Scaffolds for Galois module theory.*

The notion of a Galois scaffold was introduced in (Proc AMS 137 #4 (2009) 1193-1203). I will discuss joint work (with Nigel Byott) concerning the implications of a Galois scaffold in the classical setting of Galois module theory as well as work that extends the concept of a scaffold beyond this classical setting. (Received December 28, 2011)

1079-11-190 **Paul Richard Buckingham*** (p.r.buckingham@ualberta.ca). *Replacing zero with something interesting (or how to cope with the vanishing of p -adic L -functions of odd characters).*

Classically, p -adic L -functions p -adically interpolated Dirichlet L -functions at negative integers. In the case of an odd character, the values that are interpolated are all zero, so that the corresponding p -adic L -function is zero as well. This means that in Iwasawa's formulation of his Main Conjecture on the relationship between p -adic L -functions and the Iwasawa module (now a theorem, thanks to Mazur-Wiles and later Wiles), the statement concerns only even characters and the minus part of the Iwasawa module. We describe a situation in which one can fill in the gap left by the trivial p -adic L -functions to say something non-trivial about the plus part of the Iwasawa module. (Received January 12, 2012)

1079-11-193 **Francis Castro*** (franciscastr@gmail.com), University of Puerto Rico, Department of Mathematics, San Juan, PR 00936-8377, and **Francis N. Castro** (francis.noel.castro@hotmail.com), University of Puerto Rico, San Juan, PR. .

In this work, we will introduce the p -weight degree of a polynomial over finite field with respect to a subset of the variables of the polynomial. Using the p -weight degree of a polynomial with respect to a subset of the variables of the polynomial, we improve the results of Moreno-Moreno (**Improvements of the Chevalley-Waring and the Ax-Katz theorems**, *Amer. J. Math.*) for polynomial equations and for exponential sums over finite fields. We prove that our results cannot be improved in general because a family of polynomials where our bounds are attained is provided. Our results give a p -adic version of the results of Cao in **Dilation of Newton Polytope and p -adic Estimate**, *Discrete Comput. Geom.* and **A Partial Improvement of the Ax-Katz Theorem**, *J. Num. Theory*. Combining our result with a result of Cao-Sun (**A Reduction for Counting the Number of Solutions of the General Diagonal Equations over Finite Fields**, *Finte Fields and Their Appl.*), we give an improvement to the p -divisibility of the general diagonal equation. This result generalizes the main result in **Optimal divisibility for certain diagonal equations over finite fields**, *J. Ramanujan Math. Soc.*.

(Received January 12, 2012)

1079-11-219 **Kevin Keating*** (keating@ufl.edu), Kevin Keating, Department of Mathematics, University of Florida, Gainesville, FL 32611. *Indices of inseparability in extensions of power series fields.*

Let F be a finite field with $q = p^r$ elements and let $K = F((t))$ be the field of formal Laurent series in one variable over F . Let L/K be a finite totally ramified Galois extension. Then $L \cong F((u))$ for some $u \in L$, and there is a unique power series $\psi(X) \in F[[X]]$ such that $t = \psi(u)$. Fried and Heiermann defined the “indices of inseparability” of the extension L/K in terms of the coefficients of $\psi(X)$. In this talk we will define the indices of inseparability and give a method for computing the indices of inseparability of L/K in terms of the norm group $N_{L/K}(L^\times)$ in the case where $\text{Gal}(L/K)$ is an elementary abelian p -group with a single ramification break. In some cases our methods lead to simple formulas for the indices of inseparability. (Received January 13, 2012)

1079-11-249 **Daniel Macias Castillo*** (daniel.macias_castillo@kcl.ac.uk), Math. Inst. Univ. Munchen, D-80333 Munich, Bavaria, Germany. *On Mordell-Weil, Tate-Shafarevich and Bloch-Kato.*

This is joint work with D. Burns and C. Wuthrich. Given an abelian variety A defined over a number field k , a prime number p and a finite Galois extension F of k , we describe how, under some not-too-stringent conditions, there is a very strong interplay between the $\text{Gal}(F/k)$ -module structures of the pro- p -completion of the Mordell-Weil group and of the p -primary Tate-Shafarevich group of A over F . This allows us in certain cases to prove structure results about the pro- p -completion of the Mordell-Weil group of A over F , which we will in turn use to make completely explicit the relevant case of the equivariant Tamagawa number conjecture. In particular, we obtain the first (theoretical and numerical) verifications of the p -part of the ETNC in the technically most demanding case in which $A(F)$ has strictly positive rank and $\text{Gal}(F/k)$ is non-abelian and of order divisible by p . (Received January 16, 2012)

1079-11-252 **Alan Koch*** (akoch@agnesscott.edu), Department of Mathematics, Agnes Scott College, 141 E. College Ave., Decatur, GA 30030. *Monogenic Hopf algebras in high ramification.* Preliminary report.

Let k be a field of characteristic $p > 2$, and let R be a totally ramified extension of the ring of Witt vectors $W(k)$. Abelian Hopf algebras of p -power rank correspond to Breuil-Kisin modules, i.e., modules over $W(k)[[u]]$ together with a Frobenius-semilinear map φ satisfying certain properties. However, for a given Breuil-Kisin module it is difficult to give a concrete description of the corresponding Hopf algebra. Here, we give criteria for when a Breuil-Kisin module corresponds to a monogenic Hopf algebra, and provide examples that give some insight into the coalgebra structure of the corresponding Hopf algebra. We make no assumptions on the amount of ramification present. (Received January 16, 2012)

1079-11-269 **Qingquan Wu*** (qingquan.wu@tamiu.edu), 5201 University Blvd, EMAP, TAMIU, Laredo, TX 78041. *The divisor class number of Eisenstein cubic function fields.*

We get a lower bound of the 3-torsion part of the divisor class group of Eisenstein-type cubic function fields of characteristic other than 3. The (non-singular) Picard curve case is well-known. As far as we know, this is the first result of singular cubic curves on the positive direction. As for the number field case, Gauss’s genus theory

tells us the 2-torsion part of the narrow ideal class group of quadratic number fields. Cohen-Lenstra heuristic covers the rest cases.

This is joint work with Tobias Bembom and Renate Scheidler. (Received January 16, 2012)

1079-11-274 **Caleb McKinley Shor*** (cshor@wne.edu), Box H-5156, 1215 Wilbraham Rd, Springfield, MA 01119. *Codes over rings of square cardinality, lattices, theta functions, and specific examples.* Preliminary report.

Let $\ell > 0$ be a square-free integer congruent to 3 mod 4 and \mathcal{O}_K the ring of integers of the imaginary quadratic field $K = \mathbb{Q}(\sqrt{-\ell})$. Let p be a prime. If $p \nmid \ell$ then the ring $\mathcal{R} := \mathcal{O}_K/p\mathcal{O}_K$ is isomorphic to \mathbb{F}_{p^2} or $\mathbb{F}_p \times \mathbb{F}_p$. Let C be a code over \mathcal{R} . Given such a code, one can create a lattice $\Lambda_\ell(C)$ over K . One can then construct the corresponding theta function of such a lattice.

In 2005, working with $p = 2$, K. S. Chua found an example of two non-equivalent codes that have the same theta function for $\ell = 7$ and different theta functions for larger values of ℓ . In this talk, motivated by Chua's example, we will consider the situation for general primes p . In particular, we will see how to represent these theta functions in terms of some basic theta series and see connections between these theta functions and weight enumerator polynomials. We will then see recent results involving explicit examples of non-equivalent codes with the primes $p = 2, 3, 5$ that have the same theta function for certain values of ℓ . (Received January 16, 2012)

1079-11-314 **Ivelisse Rubio*** (iverubio@gmail.com), **Francis N. Castro** and **Luis A. Medina**. *Application of the Covering Method to Divisibility of Boolean Functions.*

The *covering method* is a combinatorial method introduced by Moreno-Moreno that provides an elementary way to estimate the divisibility of exponential sums over the binary field. Using this method, they improved Ax's theorem for the binary case. Recently, Castro-Randriam-Rubio-Mattson generalized the use of the covering method to any finite field providing an elementary approach to compute the p -divisibility of exponential sums of polynomials over prime fields. Castro-Medina-Rubio used this method to compute the exact 2-divisibility of exponential sums of boolean functions with prescribed leading monomials and, as an application, families of boolean functions that are not balanced, and sufficient conditions for the solvability of systems of boolean equations were given.

In this paper we consider families of boolean functions where the number of minimal coverings is greater than one. This case is much harder than the cases previously considered, where the families have only one minimal covering. Using the covering method, we compute the exact 2-divisibility of exponential sums of polynomials where the leading monomials are symmetric. Also, we compute the exact 2-divisibility of exponential sums of deformations of symmetric or homogeneous boolean functions. (Received January 17, 2012)

1079-11-364 **Qiang Wang*** (wang@math.carleton.ca), 1125 Colonel By Drive, Ottawa, ON K1S5B6, Canada. *On a conjecture of polynomials over finite fields with prescribed range.*

We show that, for any integer ℓ with $q - \sqrt{p} - 1 \leq \ell < q - 3$ where $q = p^n$ and $p > 9$, there exists a multiset M satisfying that $0 \in M$ has the highest multiplicity ℓ and $\sum_{b \in M} b = 0$ such that every polynomial over finite fields \mathbb{F}_q with the prescribed range M has degree greater than ℓ . This disproves a recent conjecture by Gács et al. (Permutations, hyperplanes and polynomials over finite fields, *Finite Fields Appl.* 16 (2010), 301-314). This is a joint work with Amela Muratović-Ribić. (Received January 18, 2012)

1079-11-366 **Asher Auel*** (aael@mathcs.emory.edu), Department of Mathematics & CS, Emory University, Atlanta, GA 30322. *Fröhlich twisting via orthogonal motives.* Preliminary report.

T. Saito has formulated a conjecture relating the 2nd Stiefel–Whitney and Hasse–Witt invariants of the ℓ -adic and de Rham cohomology, respectively, of a proper smooth scheme of even dimension over a field of characteristic not 2. In dimension 0, this recovers Serre's formula concerning invariants of the trace form of a finite separable extension. In this talk, we present a framework for generalizing Saito's conjecture to the context of orthogonal motives. In the case of orthogonal motives of weight 0, de Rham cohomology has a natural interpretation as the “Fröhlich twist” and our generalization of Saito's conjecture recovers (and provides a new meaning for) Fröhlich's formula comparing invariants of quadratic modules twisted by Galois representations. (Received January 18, 2012)

1079-11-395 **Emma Previato*** (ep@bu.edu), Boston University, Department of Mathematics and Statistics, Boston, MA 02215-2411. *Modular Jacobians over finite fields.*

In the theoretical and computational vein of the work of D. Maisner and E. Nart (joined by E.W. Howe and C. Ritzenthaler on follow-ups), who provide thorough information on splittability of Jacobians of curves of genus two over finite fields, we analyze the genus-two Jacobians of modular curves $X_0(N)$ to detect further properties,

and begin a program of determining splittability of the Jacobians of $X_0(N)$ in genus three. Side issues that we address include the automorphism group of the curve, and the p -rank, where p is the characteristic of the field. These issues have applications to cryptography: one technique that has recently appeared in the literature is the Richelot isogeny, a generalization of Gauss's Arithmetic-geometric Mean; however, a practical implementation requires the elliptic curve to be supersingular. We propose to explore it using the characteristic zero counterpart where Richelot isogenies were recently implemented in the theory of the Kowalevski top (D. Markushevich). This is a joint project with E. Ozman. (Received January 18, 2012)

12 ► *Field theory and polynomials*

1079-12-145 **Sophie Huczynska**, University of St. Andrews, **Gary L Mullen*** (mullen@math.psu.edu), Department of Mathematics, Pennsylvania State University, University Park, PA 16802, **Daniel Panario**, Carleton University, and **David Thomson**, Carleton University. *K-Normal Elements of Finite Fields*. Preliminary report.

The finite field F_{q^n} can be viewed as a vector space of dimension n over F_q . An element $\alpha \in F_{q^n}$ generates a *normal basis* if the powers α^{q^i} , $i = 0, 1, \dots, n-1$ form a basis. Such a basis is very useful in finite field arithmetic, in particular when q -th powering field elements.

It is known that an element α generates a normal basis if and only if the polynomial $g_\alpha(x) = \alpha x^{n-1} + \alpha^q x^{n-2} + \dots + \alpha^{q^{n-1}}$ and $x^n - 1$ are relatively prime.

We call an element α *k-normal* if the gcd of $g_\alpha(x)$ and $x^n - 1$ has degree k . We will discuss various results concerning the existence and number of k -normal elements. We will also discuss the existence of primitive k -normal elements for small values of k . (Received January 09, 2012)

1079-12-182 **Lindsay N. Childs*** (lchilds@albany.edu). *Fixed point free pairs of homomorphisms and Hopf Galois structures*.

Given finite groups Γ and G of order n , it is known that regular embeddings from Γ to the holomorph of G yield Hopf Galois structures on a Galois extension $L|K$ of fields with Galois group Γ given by K -Hopf algebras H whose associated group is G . We consider regular embeddings that arise from fixed point free pairs of homomorphisms from Γ to G . When Γ and G are isomorphic and one homomorphism is the identity, then regular embeddings arise from fixed point free endomorphisms of G , an approach that, for example, yields all regular embeddings from S_n to $Hol(S_n)$ for $n > 6$. If G is a complete group, then all regular embeddings from Γ to G arise from fixed point free pairs. We compute some examples. Kohl (1997) proved that if p is an odd prime and Γ is a cyclic group of order p^n , then every Hopf Galois structure on a Galois extension of fields with Galois group Γ has associated group Γ , and hence is abelian. Using fixed point free pairs, we prove that if p is an odd prime and Γ is a non-cyclic abelian p -group of order p^n , $n \geq 3$, then $L|K$ admits a non-abelian Hopf Galois structure. (Received January 11, 2012)

1079-12-189 **David Thomson*** (dthomson@math.carleton.ca), School of Mathematics and Statistics, Carleton University, 1125 Colonel By Dr., Ottawa, Ontario K1V6W6, Canada. *Extending the Hansen-Mullen Conjectures*. Preliminary report.

The Hansen-Mullen (H/M) conjectures state that, with a small number of genuine exceptions, there is an irreducible (resp. primitive) polynomial of degree $n \geq 2$ where any one coefficient is prescribed to a field value. These conjectures were proven in their entirety in 1998 (resp. 2008) and spawned a large body of work on distributions of specific types of polynomials over finite fields. In this work, we consider quantitative refinements of the original H/M conjectures dealing with the number of irreducibles (resp. primitives) with a prescribed coefficient.

This work is joint with Gary L. Mullen (Penn State) and Frank Ruskey (Victoria). (Received January 12, 2012)

1079-12-353 **Daniel Panario*** (daniel@math.carleton.ca). *Cycle structure of permutation functions and their applications in turbo codes*.

We establish some new interleavers for turbo codes based on permutation functions over finite fields. The inverses of these functions are known. We note that these interleavers can be used to construct good turbo code structures. We use Dickson, Mobius and Redei functions to give new deterministic interleavers. In the case of Redei functions, an exact formula for the inverse function as well as the cycle structure of Redei functions are investigated. In addition, self-inverse and non-self-inverse versions of permutation functions are used to construct interleavers. The benefit of self-inverse interleavers is that they are their own deinterleavers and this could be

helpful for turbo decoding. Finally, we carry out experiments, and the performance of these interleavers are reported. (Received January 17, 2012)

13 ► Commutative rings and algebras

1079-13-253 **Robert G Underwood*** (runderwo@aum.edu), Department of Mathematics, Auburn University Montgomery, P.O. Box 244023, Montgomery, AL 36124-4023. *On the Cyclic Decomposition of the Hopf-Swan Subgroup*. Preliminary report.

Let p be a rational prime and let $G = C_p$ denote the cyclic group of order p . For $n \geq 1$, let ζ_{p^n} denote a primitive p^n th root of unity and put $K = \mathbb{Q}(\zeta_{p^n})$, with ring of integers R . Let H be an R -Hopf order in KG , let $\mathcal{C}(H)$ denote the class group of H , and let $\mathcal{T}(H)$ denote the Hopf-Swan subgroup of $\mathcal{C}(H)$. In this paper we review some results on the structure of $\mathcal{T}(H)$ for the cases $n = 1, 2$. (Received January 16, 2012)

1079-13-268 **Timothy B.P. Clark** and **Sonja Mapes*** (smapes1@nd.edu), Mathematics Department, University of Notre Dame, Notre Dame, IN 46556. *Poset resolutions and rigid monomial ideals*. Preliminary report.

Finite atomic lattices, which arise as the lcm-lattice of a monomial ideal, play an important role in studying free resolutions of monomial ideals. In this talk I will discuss this relationship as well as give a brief description of Clark's poset resolution construction. This construction can be seen as a more combinatorial analog to cellular resolutions. Using the poset resolution construction we can construct the minimal resolution of a certain class of rigid monomial ideals and we hope to extend our result to all rigid monomial ideals. (Received January 16, 2012)

1079-13-302 **Sergio Lopez-Permouth**, **Hakan Ozadam**, **Ferruh Ozbudak** and **Steve Szabo*** (steve.szabo@eku.edu). *Polycyclic Codes over Galois Rings with Applications to Repeated-Root Constacyclic Codes*.

Cyclic, negacyclic and constacyclic codes are part of a larger class of codes called polycyclic codes. These are codes which can be viewed as ideals of a factor ring of a polynomial ring. The ambient ring of polycyclic codes over $GR(p^a, m)$ is studied here. Along with some structure details of the ambient ring, the existence of a certain type of generating set for an ideal is proven. It is shown that these generating sets are strong Groebner bases. A method for finding such sets in the case that $a = 2$ is also given. The Hamming distance of certain constacyclic codes of length np^s and $2np^s$ over F_{p^m} is computed. A method, which determines the Hamming distance of the constacyclic codes of length np^s and $2np^s$ over $GR(p^a, m)$, is described. In particular, the Hamming distance of all cyclic codes of length p^s over $GR(p^2, m)$ and all negacyclic codes of length $2p^s$ over F_{pm} is determined explicitly. (Received January 17, 2012)

14 ► Algebraic geometry

1079-14-8 **Valmira Hoxha*** (vhoxha@risat.org), 368 SEB, Department of Mathematics, Rochester, MI 48309. *SL(2, k)-invariants of superelliptic curves*. Preliminary report.

In this talk we describe different families of superelliptic curves based on their group of automorphisms. Necessary conditions are given in terms SL(2, k)-invariants of binary forms for curves of each family. These conditions give a nice connection between classical invariant theory and modern theory of algebraic curves. Moreover they are quite efficient to compute and provide a fast check in determining the automorphism group of the curve. (Received August 29, 2011)

1079-14-9 **Lubjana Beshaj*** (beshaj@oakland.edu), 368 SEB, Department of Mathematics, Rochester, MI 48309. *Half-integer thetanulls of some genus 6 curves*.

We discuss how to determine the equation of the curve in terms of half-integer thetanulls. We discuss three families of curves of genus 6, namely genus 6 curves with an automorphism of order 3, 4, and 5. Some general remarks will be given for curves of genus g . (Received August 29, 2011)

1079-14-10 **Dorina Hoxhaj*** (hoxhaj@oakland.edu), 368 SEB, Department of Mathematics, Rochester, MI 48309. *Superelliptic curves of genus $g < 100$* .

We give an algorithm of how to compute a list of all superelliptic curves of genus $g < 100$ defined over a field of characteristic different from 2. This was a major computational effort. Such curves are quite important in applications such as cryptography, coding theory, etc (Received August 29, 2011)

1079-14-24 **Christopher Brooks** and **Abraham Martin del Campo*** (asanchez@math.tamu.edu), Department of Mathematics, Texas A&M University, College Station, TX 77843-3368, and **Frank Sottile** (sottile@math.tamu.edu), Department of Mathematics, Texas A&M University, College Station, TX 77843-3368. *Galois groups of Schubert problems of lines are at least alternating.*

The Galois group of a problem in enumerative geometry is a subtle invariant that encodes special structures in the set of solutions. This invariant was first introduced by Jordan in 1870. In 1979, Harris showed that the Galois group of such problems coincides with the monodromy group of the total space. These geometric invariants are difficult to determine in general. However, a consequence of Vakil's geometric Littlewood-Richardson rule is a combinatorial criterion to determine if a Schubert problem on a Grassmannian contains at least the alternating group. Using Vakil's criterion, we showed that for Schubert problems of lines, the Galois group is at least the alternating group. (Received January 11, 2012)

1079-14-25 **Ivan Soprunov***, Department of Mathematics, Cleveland State University, 2121 Euclid Ave, Cleveland, OH 44115. *Minimum distance bounds for toric complete intersection codes.*

We consider evaluation codes constructed from zero-dimensional complete intersections in toric varieties. We give two lower bounds for the minimum distance of such codes: for complete intersections with and without a "generality" condition. This generalizes earlier results of Gold-Little-Schenck and Ballico-Fontanari who considered evaluation codes on complete intersections in the projective space. (Received November 10, 2011)

1079-14-26 **Anton Leykin** and **Abraham Martin del Campo*** (asanchez@math.tamu.edu), Department of Mathematics, Texas A&M University, College Station, TX 77843-3368. *Exploring the NumericalSchubertCalculus package.* Preliminary report.

Schubert calculus is an important class of geometric problems involving linear spaces. Problems in Schubert calculus can be modeled by systems of polynomial equations. Thus, we can use numerical methods to find the solutions to this geometrical problems.

We are working on the implementation of algorithms to solve Schubert problems using numerical homotopy continuation, a method that is part of the foundations for numerical algebraic geometry.

Anton Leykin and I are developing a package (named NumericalSchubertCalculus) for the commutative algebra software Macaulay2 devoted to solve Schubert problems numerically. Currently, our package has an implementation of simple Pieri homotopies, and we are working on the extension to the Littlewood-Richardson homotopies. Additionally, we use our package to explore Galois groups of Schubert problems.

In this talk I will explain the background and the functionality of this software, followed by a software demonstration. (Received November 10, 2011)

1079-14-31 **James S. Wolper***, Idaho State University, Pocatello, ID 83209-8085. *Information-theoretic Properties of the Periods of Hyperelliptic Curves.* Preliminary report.

The goal of the *Information Theoretic Schottky Problem* is to distinguish Jacobians from general Abelian Varieties by treating the period matrix as a signal and taking advantage of its intrinsic compressibility. This leads to a focus on the statistical distribution of the periods, which only makes sense for large genus.

This talk will present numerical evidence for conjectures, and some theorems, about the distribution of the periods of hyperelliptic curves. (Received November 22, 2011)

1079-14-91 **Eustrat Zhupa*** (ezhupa@risat.org), Vlora, Albania, and **Tony Shaska**, Rochester, MI. *Families of genus two curves with many elliptic subcovers.*

In this paper we determine all genus 2 curves which have simultaneously degree 2 and degree 3 elliptic subcovers. The locus of such curves has three irreducible 1-dimensional genus zero components in \mathcal{M}_2 . For each component we find a rational parametrization and then construct the equation of the corresponding genus 2 curve and its elliptic subcovers in terms of these parameters.. (Received December 24, 2011)

1079-14-106 **Lex E. Renner*** (lex@uwo.ca), Department of Mathematics, London, Ontario N6A 5B7, Canada. *Descent Systems and Simple Embeddings.*

Let G be a simple algebraic group with Weyl group (W, S) and let $w \in W$. It is widely appreciated that the *descent set* $D(w) = \{s \in S \mid l(ws) < l(w)\}$ determines an important chapter in the study of algebraic groups. We generalize some of those results to the situation of the Bruhat poset W^J , where $J \subset S$. Our main results here include the identification of a certain subset $S^J \subset W^J$ that plays the role of $S \subset W$ in the well known case $J = \emptyset$. The point here is to encode the relevant information in the resulting *descent system* (W^J, S^J) .

Each subset $J \subset S$ determines a projective, simple $G \times G$ -embedding $\mathbb{P}(J)$ of G . We obtain a complete list of all subsets $J \subset S$ such that $\mathbb{P}(J)$ is a *rationally smooth* algebraic variety. In such cases we determine the Betti

numbers of $\mathbb{P}(J)$ in terms of (W^J, S^J) . It turns out that $\mathbb{P}(J)$ can be decomposed into a union of “rational” cells. The descent system is used here to determine the dimension of each cell. (Received December 30, 2011)

1079-14-126 **Milagros Izquierdo*** (milagros.izquierdo@liu.se), Department of Mathematics, Linköping University, 58183 Linköping, Sweden, and **Gabriel Bartolini** (gabar@mai.liu.se). *Automorphisms groups of real cyclic p-gonal Riemann surfaces.*

A real cyclic p-gonal Riemann surface can be seen as a complex curve with equation of the form $y^p = Q(x)$, where $Q(x)$ is a polynomial over the real numbers. We find the automorphisms groups of real cyclic p-gonal Riemann surfaces for p a odd prime number. the automorphisms groups of hyperelliptic Riemann surfaces where described by Bujalance, Cirre, Gamboa and Gromadzki. (Received January 05, 2012)

1079-14-235 **Artur Elezi*** (aelezi@american.edu) and **Tony Shaska** (shaska@oakland.edu). *Quantum Codes from superelliptic curves.*

Let \mathcal{X} be an algebraic curve of genus $g \geq 2$ defined over a finite field of characteristic $p > 0$. Under certain conditions, an algebraic geometry code C is constructed from \mathcal{X} . If the code C is self-orthogonal under the symplectic product, then a related quantum code Q is constructed. In this talk we detail (a) the construction of such codes when \mathcal{X} has automorphisms, and (b) the relations between the automorphism groups of \mathcal{X} , C and Q . (Received January 15, 2012)

1079-14-242 **Li Li***, Department of Math and Statistics, Oakland University, Rochester, MI 48309, and **Alex Yong**, Mathematics Department, University of Illinois, Urbana, IL 61801. *Singularities of Schubert Varieties.*

The talk will focus on two invariants of Schubert varieties which are polynomials defined on pairs of permutations in the symmetric group. The first invariant is the celebrated Kazhdan-Lusztig polynomials defined using Hecke algebras. The second invariant is the h-polynomials of the local rings of Schubert varieties. We introduced a combinatorial concept called “drift configuration” which characterizes the second invariant for covexillary Schubert varieties, and we use this characterization to give a relation between the above two invariants. (Received January 16, 2012)

1079-14-265 **Eric Katz*** (eekatz@math.uwaterloo.ca), Department of Combinatorics & Optimization, University of Waterloo, 200 University Avenue West, Waterloo, Ontario N2L 3G1, Canada. *Log-concavity of characteristic polynomials and tropical intersection theory.*

In a recent joint work with June Huh, we proved the log-concavity of the characteristic polynomial of a realizable matroid by relating its coefficients to intersection numbers on an algebraic variety and applying an algebraic geometric inequality. In this talk, we outline that proof which involves algebraic geometric positivity. (Received January 16, 2012)

1079-14-358 **Emma Previato***, Dept of Mathematics and Statistics, Boston, MA 02215-2411. *Loci of curves of genus 3.*

The problem addressed is the following: give explicit equations for subvarieties of the moduli space of curves of genus g which have special properties, such as: being elliptic covers; having decomposable Jacobian; having a fixed group of automorphisms; or being cyclic covers of \mathbb{P}^1 of fixed degree n . In this talk the coefficients are complex numbers. The method, which is both theoretical and computational, is to detect these properties via special linear series, and in turn by special values of the thetanulls of the curve. In this report, after reviewing the genus-2 case (E. Previato, T. Shaska and S. Wijesiri, *Albanian J. Math.* **1** (2007)), we investigate recent results (A. Eisenmann, H.M. Farkas, Y. Kopeliovich, N. Shepherd-Barron) on Thomae’s formulas which allow us to go from the algebraic to the analytic coefficients of the curve as point in moduli, and sketch the way we use thetanulls for the genus-3 loci. Lastly, we show a different transcendental parametrization given by values of the “higher-genus sigma function”, a generalization of Weierstrass’ σ introduced by Klein: these can be useful substitutes for thetanulls. This is a joint project with Tony Shaska. (Received January 17, 2012)

1079-14-430 **Tony Shaska*** (shaska@oakland.edu), Rochester, MI 48309. *Fundamental half-integer thetanulls for cyclic Riemann surfaces.*

We will discuss some new development of determining fundamental theta functions for genus g compact Riemann surfaces. Some techniques, using Gopel groups, have been known to XIX century mathematicians. However, these techniques give more theta functions than the moduli dimension. We will show how to pick the exact number of thetanulls for some small $g > 2$. (Received January 18, 2012)

1079-14-440 **Yusuf Mustopa*** (ymustopa@umich.edu), Department of Mathematics, East Hall, University of Michigan, Ann Arbor, MI 48103, and **Robert Lazarsfeld**. *Stability of Syzygy Bundles on Surfaces*. Preliminary report.

The syzygy bundle associated to a subvariety $X \subseteq \mathbb{P}^n$ governs the fine structure of the equations which cut out X in \mathbb{P}^n . A classical result of Ein-Lazarsfeld implies that this bundle is stable when X is a curve embedded in \mathbb{P}^n embedded by a complete linear series of large degree. In this talk I will discuss work in progress which attempts to generalize this result to surfaces. (Received January 18, 2012)

16 ► Associative rings and algebras

1079-16-41 **Aaron D Lauda*** (lauda@usc.edu), University of Southern California, 3620 S. Vermont Ave, KAP 108, Los Angeles, CA 90089-2532, and **Alexander Ellis** and **Mikhail Khovanov**. *The odd nilHecke algebra and categorified quantum $sl(2)$* .

We will discuss an odd analog of the nilHecke algebra together with its applications to symmetric functions, cohomology of flag varieties, and categorification of quantum $sl(2)$. (Received November 30, 2011)

1079-16-42 **Aaron D Lauda*** (lauda@usc.edu), University of Southern California, 3620 S. Vermont Ave, KAP 108, Los Angeles, CA 90089-2532. *Towards odd Khovanov homology via odd categorified quantum groups*.

Khovanov homology is a categorification of the Jones polynomial that paved the way for other categorifications of quantum link invariants. The theory of categorified quantum groups provides a representation theoretic explanation of these homological link invariants via the work of Webster and others. Surprisingly, the categorification of the Jones polynomial is not unique. Ozsvath, Rasmussen, and Szabo introduced an "odd" analog of Khovanov homology that also categorifies the Jones polynomial, and the even and odd categorification are not equivalent. In this talk I will explain joint work with Alexander Ellis and Mikhail Khovanov that aims to develop odd analogs of categorified quantum groups to give a representation theoretic explanation of odd Khovanov homology. (Received November 30, 2011)

1079-16-83 **Houssein El Turkey**, Dept. of Mathematics, University of Oklahoma, Norman, OK, and **Jonathan Kujawa***, Dept. of Mathematics, University of Oklahoma, Norman, OK. *Presenting Schur superalgebras*.

The symmetric group and the Lie superalgebra $gl(m,n)$ are in Schur-Weyl duality and the finite dimensional Schur superalgebra acts as the bridge. In the spirit of the work of Doty and Giaquinto in the classical case, we show that the Schur superalgebra has a nice presentation by generators and relations. We also discuss our analogous results in the quantum setting. (Received December 20, 2011)

1079-16-150 **Timothy Kohl*** (tkohl@math.bu.edu), Department of Mathematics and Statistics, Boston University, 111 Cummington Street, Boston, MA 02215. *Hopf Galois Structures Arising from Mutually Normalizing Permutation Groups*.

The Hopf-Galois structures on a Galois extension L/K with $G = Gal(L/K)$ are in direct correspondence with the regular subgroups N of $Perm(G)$ normalized by the left regular representation of G . We consider how such N are parametrized as conjugates of a fixed regular subgroup. Furthermore, we consider those structures where the groups N are subgroups of the holomorph of G normalized by $\lambda(G)$ and isomorphic to G , which are therefore conjugates of $\lambda(G)$. We show that one can choose a set of parameters for such N which form a groupoid within $Perm(G)$, and in some special instances a full group. (Received January 17, 2012)

1079-16-156 **L Krop*** (lkrop@condor.depaul.edu), Department of Mathematical Sciences, Chicago, IL 60614, and **Y Kashina**. *Isomorphism Types of Extensions of Hopf Algebras*.

We give a necessary and sufficient conditions for isomorphism of two Hopf algebras in the class of Hopf algebra extensions of the group algebra kC_p of a cyclic group C_p of prime order p by the Hopf algebra dual k^G of the group algebra kG of a finite abelian p -group G over an algebraically closed field of characteristic 0. (Received January 10, 2012)

1079-16-293 **Brian Parshall** and **Leonard Scott*** (lls21@virginia.edu). *Forced gradings in integral quasi-hereditary algebras*.

A forced grading for a finite dimensional algebra A over a field is the graded algebra $gr A$, the direct sum of the sections of the radical power filtration of A . If A has a positive grading, generated in grade 1, with grade 0 a semisimple algebra, then the graded algebra A is isomorphic to $gr A$. However, consideration of $gr A$ potentially

can potentially reap the rewards of a positive grading, even when no positive grading on A is available. The difficulty, of course, is that the formal nature of $\text{gr } A$ makes it quite difficult to transport good properties of A , such as the quasi-hereditary property, to $\text{gr } A$. Nevertheless, the authors have achieved this in some natural cases arising in Lie theory. In this paper they take up similar questions when A is an algebra over a discrete valuation domain, and $\text{gr } A$ is given a (new) appropriate definition. Applications will be discussed as time permits. (Received January 17, 2012)

1079-16-348 **Ian M Musson***, Department of Mathematical Sciences, UW-Milwaukee, Milwaukee, WI 53201-0413. *Šapovalov elements for basic classical simple Lie superalgebras*. Preliminary report.

Šapovalov elements play a key role in the representation theory of a complex semisimple Lie algebra. We construct Šapovalov elements in the enveloping algebra of a basic classical simple Lie superalgebra, prove their uniqueness and study their properties.

Šapovalov elements corresponding to non-isotropic roots behave in a way that is very similar to the semisimple case. However new phenomena arise from isotropic roots. (Received January 17, 2012)

1079-16-363 **Alexander P. Ellis***, ellis@math.columbia.edu, and **Mikhail Khovanov** and **Aaron Lauda**. *The Hopf algebra of odd symmetric functions*.

We introduce the odd symmetric functions, a \mathbb{Z} -graded Hopf superalgebra which exhibits signed analogues of many of the combinatorial properties of the classical symmetric functions: elementary and complete bases, Kostka numbers, Schur functions, RSK and Littlewood-Richardson, and so forth. This superalgebra is obtained as a quotient of a q -Hopf algebra isomorphic to the graded dual of the quantum quasi-symmetric functions. It also arises as the kernel of odd divided difference operators which act on skew polynomials; these operators are part of an odd nilHecke algebra. Odd nilHecke algebras can be used to categorify half of quantum $\mathfrak{sl}(2)$ and, conjecturally, give a 2-representation theoretic construction of odd Khovanov homology. In this talk, we will focus on the odd symmetric functions themselves; Aaron Lauda's talk in this same session will cover the odd nilHecke algebra and categorification. (Received January 18, 2012)

1079-16-391 **William Chin*** (chin.bill@gmail.com), Dept. of Mathematical Sciences, DePaul University, Chicago, IL 60610. *Galois coverings of coalgebras*.

We introduce the concept of a Galois covering of a pointed coalgebra. By an analog of a fundamental result of Gabriel, a pointed coalgebra embeds into the path coalgebra of its quiver. Topological coverings of quivers are used to construct covering coalgebras, including a universal covering for a path subcoalgebra of the path coalgebra. The theory developed shows that Galois coverings of coalgebras can be expressed by smash coproducts using the coaction of the automorphism group of the covering. Thus the theory of Galois coverings of pointed coalgebras is seen to be equivalent to group gradings of coalgebras, and representations of coverings are equivalent to graded comodules. Gradings in connection to coverings of quivers and representation theory were studied in the 80's by Green, Martinez-de la Pena, Bongartz and Gabriel, Riedtman, and recently for k -categories by Cibils and Marcos. One feature of the coalgebra theory is that neither the grading group nor the quiver is assumed finite in order to obtain a smash product coalgebra. (Received January 18, 2012)

17 ► *Nonassociative rings and algebras*

1079-17-4 **Weiqiang Wang*** (ww9c@virginia.edu), Department of Mathematics, University of Virginia, Charlottesville, VA 22904. *What is super in representation theory of Lie superalgebras?*

The notion of Lie superalgebras is obtained from Lie algebras by an innocent change of signs and is motivated largely by supersymmetry, but the sign change causes all kind of difficulties in super representation theory. We will review some of the well-known development in the 20th century for irreducible characters of semisimple Lie algebras from the Weyl character formula to Kazhdan-Lusztig theory for Bernstein-Gelfand-Gelfand category O . We will explain why representations of Lie superalgebras are so dramatically different by examples, what difficulties lie in some traditional approaches to super representation theory while noting similarities to representations of semisimple Lie algebras. Then we present how some recent approach developed in the 21st century using canonical basis and category equivalence helps to solve longstanding problems and conjectures on irreducible characters in (parabolic) Bernstein-Gelfand-Gelfand categories for Lie superalgebras. The connection to symmetric functions plays a fundamental role. (Received September 24, 2011)

1079-17-22 **Nicolas Guay*** (nguay@ualberta.ca), University of Alberta, Department of Mathematical Sciences, CAB 632, Edmonton, Alberta T6G 2G1, Canada, and **Xiaoguang Ma**. *Twisted quantum loop algebras and affine Hecke algebras of type BC*.

We introduce a family of coideal subalgebras of the quantum loop algebra of the general linear Lie algebra which will be called twisted quantum loop algebras of type AIII. We will explain some of their properties and how their representation theory is connected to affine Hecke algebras of type BC. Similar results hold for twisted Yangians and degenerate affine Hecke algebras. (Received November 04, 2011)

1079-17-85 **Eric Sommers*** (esommers@math.umass.edu), Department of Math and Stats, LGRT, UMass, Amherst, MA 01003. *The singularities of slices in the nilpotent cone*. Preliminary report.

We report on the classification of singularities of slices between adjacent orbits in nilpotent cones, a story begun by Slodowy between the regular and subregular nilpotent orbits and solved completely by Kraft and Procesi in the classical groups. Of particular interest are slices associated to special pieces and between adjacent special orbits. A beautiful duality shows up when one focuses on the special nilpotent orbits, extending the phenomenon discovered by Kraft and Procesi in the case of GL_n . This is joint work with Fu, Juteau and Levy. (Received December 20, 2011)

1079-17-149 **Brian D Boe*** (brian@math.uga.edu), Department of Mathematics, University of Georgia, Athens, GA 30602, **Jonathan R Kujawa**, Department of Mathematics, University of Oklahoma, Norman, OK 73019, and **Daniel K Nakano**, Department of Mathematics, University of Georgia, Athens, GA 30602. *Complexity for modules over the classical Lie superalgebra $\mathfrak{gl}(m|n)$* .

Let $\mathfrak{g} = \mathfrak{g}_0 \oplus \mathfrak{g}_1$ be a classical Lie superalgebra and \mathcal{F} be the category of finite dimensional \mathfrak{g} -supermodules which are completely reducible over the reductive Lie algebra \mathfrak{g}_0 . In a previous paper, the authors demonstrated that for any module M in \mathcal{F} the rate of growth of the minimal projective resolution (i.e., the complexity of M) is bounded by the dimension of \mathfrak{g}_1 . In this paper we compute the complexity of the simple modules and the Kac modules for the Lie superalgebra $\mathfrak{gl}(m|n)$. In both cases we show that the complexity is related to the atypicality of the block containing the module. (Received January 09, 2012)

1079-17-153 **Elena Poletaeva*** (elenap@utpa.edu), Dept of Mathematics, University of Texas-Pan American, 1201 West University Dr., Edinburg, TX 78539, and **Vera Serganova**. *Finite W -algebras for Lie superalgebras in the regular case*.

The finite W -algebras are certain associative algebras associated to a complex semisimple Lie algebra g and a nilpotent element e of g . A finite W -algebra W_e is a generalization of the universal enveloping algebra $U(g)$. For $e = 0$, W_e is simply $U(g)$. It is a result of B. Kostant that for a regular nilpotent element e , W_e coincides with the center of $U(g)$.

In the full generality, the finite W -algebras were introduced by A. Premet. His definition makes sense for a simple Lie superalgebra $g = \mathfrak{g}_0 \oplus \mathfrak{g}_1$ in the case when \mathfrak{g}_0 is reductive, g has an invariant symmetric bilinear form, and e is an even nilpotent element. However Kostant's result does not hold in this case.

We will show that certain results of A. Premet can be generalized for classical Lie superalgebras. We obtain the precise description of finite W -algebras for regular e for classical Lie superalgebras of Type I and defect one. We also present some partial results for the case $\mathfrak{gl}(n|n)$ and formulate a general conjecture about the structure of these algebras. (Received January 10, 2012)

1079-17-225 **Irfan Bagci***, Department of Mathematics, University of California at Riverside, Riverside, CA 92521, and **Konstantina Christodouloupoulou** and **Emilie Wiesener**. *Whittaker modules for simple Lie superalgebras*.

B. Kostant introduced a class of modules for finite dimensional complex semisimple Lie algebras. He called them Whittaker modules because of their connection with the Whittaker equations that arise in the study of the associated Lie group. Since then, a number of others have further developed the idea of Whittaker modules for Lie algebras. Recently, in joint work with K.Christodouloupoulou and E. Wiesner, I have adapted some of these ideas to the setting of Lie superalgebras. (Received January 14, 2012)

1079-17-261 **Alistair Savage*** (alistair.savage@uottawa.ca), Department of Mathematics, University of Ottawa, 585 King Edward Ave, Ottawa, Ontario K2P2H1, Canada. *Equivariant map superalgebras*.

Suppose a finite group acts on a scheme (or algebraic variety) X and a "target" Lie superalgebra \mathfrak{g} . Then the space of equivariant algebraic maps from X to \mathfrak{g} is a Lie superalgebra under pointwise multiplication. We call

this an equivariant map superalgebra. An important class of examples are the (twisted) loop superalgebras, where the variety X is the one-dimensional torus.

In this talk we will present a classification of the irreducible finite-dimensional representations of an equivariant map superalgebra where the target \mathfrak{g} is a basic classical Lie superalgebra and the group in question acts freely on X . It turns out that all irreducible finite-dimensional representations are generalized evaluation representations. In the case that the even part of \mathfrak{g} is semisimple, they are in fact all evaluation representations. As a corollary of our general result, we obtain the first classification of the twisted loop superalgebras. (Received January 16, 2012)

1079-17-266 **Maria Gorelik**, Weizmann Institute of Science, Rehovot, Israel, and **Dimitar Grantcharov*** (grandim@uta.edu), Department of Mathematics, UT Arlington, Arlington, TX 76019. *Bounded weight modules of queer Lie superalgebras*. Preliminary report.

The category of bounded weight modules consists of all modules that equal to the direct sum of their weight spaces and whose sets of weight multiplicities are uniformly bounded. This category plays an important role in the classification of all simple weight modules of both Lie algebras and Lie superalgebras. Namely, every simple weight module of a finite dimensional simple Lie superalgebra is obtained by a parabolic induction from a bounded weight module. In this talk we will discuss the classification of the simple bounded weight modules of the queer Lie superalgebras. This is a joint work with M. Gorelik. (Received January 16, 2012)

1079-17-378 **David Hill*** (dehill@virginia.edu) and **Weiqiang Wang**. *Categorification of quantum Kac-Moody superalgebras*.

We categorify (half) quantum Kac-Moody superalgebras with non-isotropic odd roots. (Received January 18, 2012)

1079-17-385 **Dijana Jakelić*** (jakelicd@uncw.edu), University of North Carolina Wilmington, Department of Mathematics and Statistics, 601 S. College Rd, Wilmington, NC 28401, and **Adriano Adrega de Moura**, University of Campinas, Brazil. *Braid group and q -characters at roots of unity*.

The notion of q -characters, introduced by E. Frenkel and N. Reshetikhin in the context of finite-dimensional representations of quantum affine algebras, is a generalization of the notion of characters of finite-dimensional representations of simple Lie algebras. The q -characters have been studied extensively in the last 10 years using geometric, combinatorial, and representation-theoretic methods.

In this talk, we will focus on a joint work with A. Moura where we consider the q -characters in the roots of unity setting. It is known that the q -characters are not invariant under the action of the braid group in general. However, we will present a result saying that, if the underlying Lie algebra is of classical type, the q -characters of fundamental representations satisfy a certain invariance property with respect to the braid group action. We will give an example describing how this result can be used to obtain explicit formulae for the q -characters of fundamental representations in the root of unity setting. (Received January 18, 2012)

20 ► Group theory and generalizations

1079-20-16 **Massmo Nespolo*** (massimo.nespolo@crm2.uhp-nancy.fr), BP 70239, Boulevard des Aiguillettes, 54506 Vandoeuvre-les-Nancy, France. *Analysis of crystal structures in terms of the eigensymmetry of crystallographic orbits and its application to twinned crystals*.

The infinite set of atoms generated by the action of the space group on each atom in the asymmetric unit (fundamental region) of a crystal structure is called a crystallographic orbit. The eigensymmetry E of each orbit is at least equal to the space group G (characteristic orbit). When E is a supergroup of G , the orbit is called non-characteristic. If $T(E)$ coincides $T(G)$, E/T is necessarily a supergroup of G/T . If instead $T(E)$ is supergroup of $T(G)$, the orbit is called extraordinary: E/T may coincide with G/T or be a supergroup of it. When heavy atoms occupy non-characteristic orbits, the diffraction pattern shows pseudo-symmetry or systematic weak diffractions, which can be exploited to build the initial model of the crystal structure. A promising application of crystallographic orbits is in the study of twins. These are oriented associations of crystals of the same compound whose respective orientations are mapped by an operation that does not belong to G/T . The crystal structures do not match at the interface. However, a substructure can be more or less continuous, if the atoms forming this substructure are on non-characteristic orbits, because the operation mapping the orientations of the crystals in the twin may be an operation of E/T without being an operation of G/T . (Received October 12, 2011)

1079-20-33 **Michael W Davis*** (mdavis@math.ohio-state.edu) and **Matthew Kahle**. *Cohomology of random graph products of groups.*

Given a graph and a collection of groups indexed by its vertex set, one can define the “graph product” of the groups. Also, there is a theory of random graphs originally due to Erdős and Renyi. So, there is a notion of a random graph products of groups. We compute the cohomological invariants of these random graph products. The most interesting result is that a random graph product of finite groups is asymptotically almost surely a virtual duality group over \mathbb{Q} . (Received November 26, 2011)

1079-20-52 **Vladimir Shpilrain***, Department of Mathematics, The City College of New York, New York, NY 10031. *On the isomorphism problem for finitely presented groups with solvable word problem.* Preliminary report.

Given two finitely presented groups with solvable word problem and given that one of the groups satisfies a “tameness” condition for generating sets, we show that one can decide whether or not these two groups are isomorphic. As one of the corollaries, we generalize several known results on the isomorphism problem for one-relator groups. (Received December 11, 2011)

1079-20-55 **Nick Wright***, University of Southampton, University Road, Southampton, SO17 1BJ, England. *Asymptotic dimension for CAT(0) cube complexes.*

In this talk I'll introduce the concept of controlled hyperplane colorings for CAT(0) cube complexes, and explain how these can be used to construct Lipschitz maps between CAT(0) cube complexes. Such colorings always exist, and this is used to prove that the asymptotic dimension of a CAT(0) cube complex is no more than its dimension. (Received December 12, 2011)

1079-20-63 **Ronghui Ji*** (ronji@math.iupui.edu), Department of Mathematical Sciences, IUPUI, 402 N. Blackford Street, Indianapolis, IN 46202, and **C. Ogle** and **B. Ramsey**. *Relative property A and relative amenability for countable groups.*

We define a relative property A for a countable group with respect to a finite family of subgroups. Many characterizations for relative property A are given. In particular a relative bounded cohomological characterization shows that if G has property A relative to a family of subgroups \mathcal{H} and if each $H \in \mathcal{H}$ has property A, then G has property A. This result leads to new classes of groups that have property A. In particular, groups are of property A if they act cocompactly on locally finite property A spaces of bounded geometry with stabilizers of property A. Specializing the definition of relative property A, an analogue definition of relative amenability for discrete groups are introduced and similar results are obtained. (Received December 13, 2011)

1079-20-127 **Peter Sin*** (sin@uf1.edu). *Weyl modules, simple modules and invariants of incidence maps.*

We report on some recent results. In work with O. Arslan, the structures of certain “classical” Weyl modules have been determined for all characteristics and the results have been applied to solve problems posed by Moorhouse on incidence matrices from projective geometry over finite fields. In work with A. Brouwer and J. Ducey, the invariant factors of the incidence matrix for skew lines in a finite 3D-space have been determined. A common theme is that computations are done over a p-adic ring rather than in characteristic p. (Received January 05, 2012)

1079-20-144 **venkatraman gopalan*** (vxg8@psu.edu), 212N , MSC bldg, University Park, PA 16802, and **daniel b litvin**. *Roto symmetries in crystals and handed structures.*

Symmetry is a powerful framework to perceive and predict the physical world. The structure of materials is described by a combination of rotations, rotation-inversions and translational symmetries. By recognizing the reversal of static structural rotations between clockwise and counterclockwise directions as a distinct symmetry operation, here we show that there are many more structural symmetries than are currently recognized in right- or left-handed helices, spirals, and in antidistorted structures composed equally of rotations of both handedness. For example, we show that many antidistorted perovskites possess twice the number of symmetry elements as conventionally identified. These new ‘roto’ symmetries predict new forms for ‘roto’ properties that relate to static rotations, such as rotoelectricity, piezotation, and rotomagnetism. They enable a symmetry-based search for new phenomena, such as multiferroicity involving a coupling of spins, electric polarization and static rotations. This work is relevant to structure–property relationships in all materials and structures with static rotations. (Received January 08, 2012)

1079-20-147 **Nham Vo Ngo*** (nham@uga.edu), Department of Mathematics, University of Georgia, Athens, GA 30602. *Commuting Varieties and Cohomology of Frobenius kernels.*

In this talk, we introduce results about commuting varieties of r -tuples of elements involving various sets of 2 by 2 matrices. Using methods in commutative algebra and geometry, we show that such varieties are irreducible, Cohen-Macaulay, and normal. Finally, we apply the representation theory of SL_2 to compute G -module structure for the coordinate algebra of the nilpotent commuting variety over \mathfrak{sl}_2 . (Received January 09, 2012)

1079-20-148 **Rémi Bernard Coulon*** (remi.coulon@vanderbilt.edu) and **Arnaud Hilion.** *Outer automorphism group of Burnside groups.*

The free Burnside group $\mathbf{B}_r(n)$ of rank r and exponent n is the quotient of the free group of rank r by the subgroup generated by the n -th powers of all elements. It was introduced at the beginning of the 20th century by W. Burnside who asked whether this group should be finite or not. It is now known that these groups are infinite for $r \geq 2$ and n “large enough”. In this talk, we are interested in the outer automorphism group of $\mathbf{B}_r(n)$. In particular we focused on the following questions. What kind of subgroups does $\text{Out}(\mathbf{B}_r(n))$ contain? What are its elements of infinite order? (Received January 09, 2012)

1079-20-155 **Lizhen Ji*** (lji@umich.edu), Dept of Math, University of Michigan, Ann Arbor, MI 48109. *On constructing an invariant complete geodesic metric on the outer space.* Preliminary report.

In this talk, we will discuss a construction of a complete geodesic metric on the outer space of metric graphs, which is invariant under the outer automorphism group $\text{Out}(F_n)$ of free group F_n . One ingredient is to relate the outer space to the moduli space of compact tropical curves. (Received January 10, 2012)

1079-20-160 **Curtis Kent*** (curt.kent@vanderbilt.edu). *Homotopy properties of asymptotic cones of groups.*

In 1991, Gromov asked what groups arise as fundamental groups of asymptotic cones of finitely generated groups. In particular, he asked if the fundamental group is always trivial or uncountable. This dichotomy was shown to be false by Olshanskii, Osin, and Sapir in 2009. However, we will show that this dichotomy holds for a large class of groups which includes aspherical groups with linear Dehn function. As a corollary of the proof, we see that these cones are locally simply connected if and only if they are semi-locally simply connected. (Received January 10, 2012)

1079-20-161 **Mikhail V Ershov*** (ershov@virginia.edu), University of Virginia, Department of Mathematics, P.O.Box 400137, Charlottesville, VA 22904, and **Andrei Jaikin-Zapirain,** Departamento de Matemáticas, Universidad Autónoma de Madrid, Cantoblanco Ciudad Universitaria, 28049 Madrid, Spain. *Residually finite monsters.*

I will briefly sketch a construction of infinite finitely generated residually finite torsion groups in which every finitely generated subgroup is either finite or of finite index. These groups can be thought of as residually finite analogues of Tarski monsters. I will also discuss some open problems related to these groups.

This is a joint work with Andrei Jaikin-Zapirain. (Received January 10, 2012)

1079-20-222 **Christopher M. Drupieski*** (cdrup@math.uga.edu), University of Georgia, Department of Mathematics, Boyd Graduate Studies Research Center, Athens, GA 30602. *Projective modules for Frobenius kernels and finite groups of Lie type.* Preliminary report.

Let G be a semisimple simply-connected algebraic group over an algebraically closed field of characteristic $p > 0$. Let $r \geq 1$ and set $q = p^r$. Let M be a finite-dimensional rational G -module. In this talk we will show that if M is projective when considered as a module over the r -th Frobenius kernel G_r of G , then M is also projective when considered as a module over the finite subgroup $G(\mathbb{F}_q)$ of \mathbb{F}_q -rational points in G . (A well-known example of a module M satisfying this property is the Steinberg module St_r .) This result generalizes previous work of Lin and Nakano, who established the result in the case $r = 1$, and is also related to recent work of Friedlander on Weil restriction and support varieties. The proof we will present in this talk is entirely non-geometric, so is interesting even for the previously-established case when $r = 1$. (Received January 14, 2012)

1079-20-245 **Zongzhu Lin** (zlin@math.ksu.edu), Department of Mathematics, Kansas State University, Manhattan, KS 66506, and **Daniel K. Nakano*** (nakano@math.uga.edu), Department of Mathematics, University of Georgia, Athens, GA 30605. *Realizing rings of regular functions via the cohomology of quantum groups.* Preliminary report.

Let G be a complex reductive group and P be a parabolic subgroup of G . In this talk I will address questions involving the realization of the G -module of the global sections of the (twisted) cotangent bundle over the

flag variety G/P via the cohomology of the small quantum group. Our main result generalizes the important computation of the cohomology ring for the small quantum group by Ginzburg and Kumar, and provides a generalization of a well-known calculation by Kumar, Lauritzen, and Thompsen to the quantum case and the parabolic setting. As an application we answer the question (first posed by Friedlander and Parshall for Frobenius kernels) about the realization of coordinate rings of Richardson orbit closures for complex semisimple groups via quantum group cohomology. Formulas will be provided which relate the multiplicities of simple G -modules in the global sections with the dimensions of extension groups over the large quantum group.

This is joint work with Zongzhu Lin. (Received January 16, 2012)

1079-20-257 **Naihuan Jing*** (jing@math.ncsu.edu), Dept of Mathematics, N. C. State University, Raleigh, NC 27695-8205. *Irreducible characters of spin wreath products.*

In connection with McKay correspondence and affine Lie algebras, Frenkel, Jing and Wang fixed the irreducible characters and determined a large part of the complex irreducible character values of spin wreath products of Γ and S_n via vertex operator calculus about ten years ago. In the current work we find the missing part of the character table for general Γ . Moreover, in the special case of abelian Γ the irreducible modules are constructed explicitly by the Mackey-Wigner method of little groups. This joint work with Xiaoli Hu. (Received January 16, 2012)

1079-20-291 **Brian Parshall***, Department of Mathematics, University of Virginia, Charlottesville, VA 22903, and **Leonard Scott** (l1s21@virginia.edu), Department of Mathematics, University of Virginia, Charlottesville, VA 22903. *A semisimple series for q -Weyl and q -Specht modules.* Preliminary report.

In earlier work, the authors investigated certain semisimple series for quantum Weyl modules at a root of unity (subject some restrictions). Subject to restrictions on the size of the characteristic, similar result were obtained for Weyl modules with highest weight in the Jantzen region. In both cases, the best results were obtained in the regular weight case, when the filtration could be taken to be the radical filtration. We discuss how, using affine Lie algebras, and working in type A , the quantum results can be obtained with no restriction on the root of unity. (These results hold in other types subject to restrictions.) Applications are given to q -Specht modules. We discuss an analogue for Weyl modules for classical Schur algebras and Specht modules for symmetric groups in positive characteristic. This work requires the validity of the James conjecture and a version of the Bipartite Conjecture. (Received January 17, 2012)

1079-20-331 **Pramod N. Achar*** (pramod@math.lsu.edu), Department of Mathematics, Louisiana State University, Baton Rouge, LA 70803-4918. *Perverse coherent sheaves on the nilpotent cone in good characteristic.*

The category of “perverse coherent sheaves on the nilpotent cone” in characteristic 0 has been used successfully by Bezrukavnikov to study various questions involving affine Weyl groups, quantum groups, and geometric Langlands duality. In this talk, I will explain some homological properties of this category and their generalizations to the case of good positive characteristic, and I will speculate about connections to the modular representation theory of algebraic groups. (Received January 17, 2012)

1079-20-333 **Matthew Housley*** (housley@math.byu.edu), **Heather M. Russell** and **Julianna S. Tymoczko.** *Skein Theory and Kazhdan-Lusztig Bases.* Preliminary report.

Kazhdan and Lusztig constructed a remarkable canonical basis of the Hecke algebra \mathcal{H} for the symmetric group which leads naturally to left cells and left cell representations. These based representations have important applications in the study of simple Lie algebras of type A . Hecke algebra representations with canonical bases can also be defined via webs and skein relations, structures arising in category theory. While web bases and Kazhdan-Lusztig left cell bases are in general not the same, I will discuss combinatorial facts that indicate a close relationship between them and suggest the possibility of using webs as a tool to compute left cell bases. (Received January 17, 2012)

1079-20-341 **George J. McNinch***, Math Department, Tufts University, 503 Boston Ave, Medford, MA 02155. *Linear factors for the action of an algebraic group on a split unipotent group.*

Let k be an arbitrary field, and let G be a linear algebraic group over k . If G acts on a vector group V over k by automorphisms of algebraic groups, the action of G on V is *linear* if there is a G -equivariant isomorphism of algebraic groups $V \simeq \text{Lie}(V)$.

In some recent work, we give examples of vector groups V having non-linear action of G . On the other hand, if the G -module $\check{A}(V)$ of additive regular functions on V is completely reducible, we show that the action of G on V is linear.

Using this latter result, we prove that if the unipotent radical of G is defined and split over k , then any split unipotent algebraic group U over k on which G acts by group automorphisms has a filtration by G -stable closed subgroups for which each successive quotient group is a vector group on which G acts linearly.

The talk will give an overview of these results. (Received January 17, 2012)

1079-20-401 **Julianne G. Rainbolt*** (rainbolt@slu.edu). *Intersections of Bruhat cells with conjugacy classes of regular elements*. Preliminary report.

Let \tilde{G} denote a connected reductive algebraic group defined over an algebraically closed field of characteristic p . Let $F : \tilde{G} \rightarrow \tilde{G}$ be a Frobenius map. Let G be the finite group of Lie type which is the fixed points of F . Let B be an F -stable Borel subgroup of \tilde{G} and let T be an F -stable maximal torus of \tilde{G} contained in B . Let $N = N_{\tilde{G}}(T)$. Denote the Weyl group of G by $W = N^F/T^F$. The element \dot{w} will denote the preimage of $w \in W$ with respect to the natural surjection from N^F to W . The double cosets $B^F \dot{w} B^F$ are called the Bruhat cells of G . An element $x \in \tilde{G}$ is called regular if the dimension of its centralizer is minimal. In this talk we will investigate the intersections of Bruhat cells with conjugacy classes of regular elements in G . (Received January 18, 2012)

22 ► Topological groups, Lie groups

1079-22-227 **Daniel S. Sage*** (sage@math.lsu.edu), Department of Mathematics, Louisiana State University, Baton Rouge, LA 70803, and **Christopher L. Bremer** (cbremer@math.lsu.edu). *Moy-Prasad filtrations and moduli spaces of flat G -bundles*.

In recent years, there has been increasing interest in flat G -bundles on curves motivated by developments in representation theory. For example, in the geometric Langlands program, the Galois side of the correspondence involves monodromy data from flat G -bundles. We describe a new approach to the study of flat G -bundles using methods of p -adic representation theory. In particular, we discuss a geometric version of the Moy-Prasad theory of fundamental strata (in their words, "unrefined minimal K -types"). We associate a fundamental stratum to a formal flat G -bundle (i.e. a bundle over $\mathbf{C}((t))$). Intuitively, this invariant plays the role of the "leading term" of a connection. An especially well-behaved class of strata are the regular strata; a formal G -bundle containing a regular stratum generalizes the naive idea of a bundle whose flat structure has regular semisimple leading term. We use this theory to construct the moduli space of flat connections (i.e., flat GL_n -bundles) on the projective line with specified regular formal types at a set of singular points. This moduli space is a symplectic reduction of a direct product of manifolds encoding local data. It also arises as a symplectic quotient of a manifold by a torus action. (Received January 14, 2012)

1079-22-287 **Huajun Huang*** (huanghu@auburn.edu), 221 Parker Hall, Department of Mathematics and Statistics, Auburn University, Auburn, AL 36849, and **Hongyu He** (hongyu@math.lsu.edu), Department of Mathematics, Louisiana State University, Baton Rouge, LA 70803. *Combinatorial properties of some Bruhat orders*.

An extension of Witt's theorem is given to study the orbits of isometry groups on flag manifolds over any field of characteristic not 2. As examples, some combinatorial properties of the Bruhat orders of certain symmetric subgroups on isotropic Grassmannians are discussed. (Received January 17, 2012)

1079-22-300 **Sam Evens** and **William Graham*** (wag@math.uga.edu). *The relative Hochschild-Serre spectral sequence and the Belkale-Kumar product*.

We consider the Belkale-Kumar cup product \odot_t on $H^*(G/P)$ for a generalized flag variety G/P with parameter $t \in \mathbf{C}^m$, where $m = \dim(H^2(G/P))$. For each $t \in \mathbf{C}^m$, we define an associated parabolic subgroup $P_K \supset P$. We show that the ring $(H^*(G/P), \odot_t)$ contains a graded subalgebra A isomorphic to $H^*(P_K/P)$ with the usual cup product, where P_K is a parabolic subgroup associated to the parameter t . Further, we prove that $(H^*(G/P_K), \odot_0)$ is the quotient of the ring $(H^*(G/P), \odot_t)$ with respect to the ideal generated by elements of positive degree of A . We prove the above results by using basic facts about the Hochschild-Serre spectral sequence for relative Lie algebra cohomology. We will discuss how to prove these facts using the original approach of Hochschild and Serre. (Received January 17, 2012)

1079-22-305 **Amber Russell*** (arusell@math.lsu.edu). *Graham's Variety and Perverse Sheaves on the Nilpotent Cone*.

In recent work, Graham has constructed a variety with a map to the nilpotent cone that is similar to the Springer resolution. However, Graham's map differs from the Springer resolution in that it is not in general an isomorphism over the principal orbit, but rather the universal covering map. This map gives rise to a certain

semisimple perverse sheaf on the nilpotent cone. In this talk, we discuss the problem of describing the summands of this perverse sheaf. (Received January 17, 2012)

1079-22-336 **Wenjing Li*** (wli@math.uga.edu). *Spiral Schubert varieties in type \tilde{A}_2* . Preliminary report.

The Bruhat order on affine Weyl groups arises from inclusions among Schubert varieties. There are integers q_x^w , defined using the Bruhat order, which have geometric significance but are hard to compute. In type \tilde{A}_2 , the Bruhat order is connected to the geometry of affine Weyl group acting on the plane. For spiral Schubert varieties, we discovered a characterization of Bruhat order in terms of the geometry of a triangle region in the plane. Using this we determine all the q_x^w and determine the set of rationally smooth points. This led to the proof of the lookup conjecture for spiral Schubert varieties $X(w(\ell))$. There are rational functions equivariant multiplicities which can detect both smoothness and rational smoothness and distinguish them. We have a precise conjecture about smooth points related to the geometry of a triangle region. (Received January 17, 2012)

30 ► *Functions of a complex variable*

1079-30-38 **Alexander M Stokolos*** (astokolos@georgiasouthern.edu), Department of Mathematics, Georgia Southern University, PO Box 8093, Statesboro, GA 30460, and **Kathryn E Hare** (kehare@uwaterloo.ca), Department of Pure Mathematics, University of Waterloo, Waterloo, ON N2L 3G1, Canada. *On the rate of tangential convergence of functions from Hardy spaces*.

Our interest is in Fatou theorem for functions which belong to the classic Hardy spaces on the disk and satisfy certain modulus of continuity properties. Such functions can have limits along tangential regions. In the talk we consider the rates of convergence of these limits. (Received November 28, 2011)

1079-30-47 **Dixan Peña Peña*** (dpp@cage.ugent.be), Clifford Research Group, Department of Mathematical Analysis, Galglaan 2, 9000 Gent, Belgium, and **Frank Sommen** (fs@cage.ugent.be), Clifford Research Group, Department of Mathematical Analysis, Galglaan 2, 9000 Gent, Belgium. *Some generalizations of Fueter's theorem*. Preliminary report.

Fueter's theorem is a fundamental result in Clifford analysis. It discloses a remarkable connection existing between the classical holomorphic functions and its higher dimensional counterpart: the monogenic functions. The aim of our talk is to provide an overview of the most important issues related to this topic, including some generalizations obtained by the authors in the last years. Examples of special monogenic functions generated by this technique will be also presented. (Received December 28, 2011)

1079-30-59 **Lisa De Castro*** (1decastro@mail.usf.edu), Department of Mathematics & Statistics, University of South Florida, 4202 E Fowler Ave, PHY114, Tampa, FL 33620-5700, and **Dmitry Khavinson**. *Analytic functions in Smirnov classes E^p with real boundary values*.

Let G be a domain bounded by Jordan rectifiable curves C_1, \dots, C_n . It is well known that for $p \geq 1$ analytic functions in E^p -classes can be represented as Cauchy integrals of their non-tangential boundary values. If all of the boundary curves are analytic then $E^p(G) = H^p(G)$ and any analytic function in Smirnov class E^p with real boundary values is a constant. However, there are non-smooth boundaries that do admit non-constant analytic functions of Smirnov class with real boundary values. We will discuss the particular boundary characteristics that are sufficient for such functions to exist. (Received December 13, 2011)

1079-30-60 **Constantin Costara** and **Thomas Ransford*** (ransford@mat.ulaval.ca), Department of Mathematics and Statistics, Laval University, Quebec City, Quebec G1V 0A6, Canada. *Which de Branges–Rovnyak spaces are Dirichlet spaces (and vice versa)?* Preliminary report.

In 1997, Sarason showed that two apparently unrelated families of Hilbert spaces overlap, namely the local Dirichlet spaces of Richter–Sundberg, and the model spaces of de Branges–Rovnyak. This had interesting consequences. We investigate the precise extent of the overlap. (Received December 13, 2011)

1079-30-81 **Frederic Gaunard*** (frederic.gaunard@math.u-bordeaux1.fr), Institut de Mathématiques de Bordeaux, 351 cours de la Liberation, 33405 Talence, France. *Minimality, (Weighted) Interpolation in Paley-Wiener Spaces & Control Theory*.

It is well known from a result by Shapiro-Shields that in the Hardy spaces, a sequence of reproducing kernels is uniformly minimal if and only if it is an unconditional basis in its span. This property which can be reformulated

in terms of interpolation and so-called weak interpolation is not true in Paley-Wiener spaces in general. Here we show that the Carleson condition on a sequence Λ together with minimality in Paley-Wiener spaces PW_{τ}^p of the associated sequence of reproducing kernels implies the interpolation property of Λ in $PW_{\tau+\epsilon}^p$, for every $\epsilon > 0$. With the same technics, using a result of McPhail, we prove a similiary result about minimlity and weighted interpolation in $PW_{\tau+\epsilon}^p$. We apply the results to control theory, establishing that, under some hypotheses, a certain weak type of controllability in time $\tau > 0$ implies exact controllability in time $\tau + \epsilon$, for every $\epsilon > 0$. (Received December 20, 2011)

1079-30-100 **David M Freeman*** (david.freeman@uc.edu), University of Cincinnati Blue Ash College, 9555 Plainfield Rd, Blue Ash, OH 45236. *Transitive bilipschitz group actions and bilipschitz parameterizations*. Preliminary report.

This talk will examine the relationship between transitive bilipschitz group actions and bilipschitz parameterizations of metric spaces. In particular, if an Ahlfors 2-regular metric space X that is quasimetrically homeomorphic to \mathbb{R}^2 admits a transitive uniformly bilipschitz group action, then the space can be parameterized by a bilipschitz homeomorphism $f : \mathbb{R}^2 \rightarrow X$. The possibility of similar results in higher dimensions will also be discussed, time permitting. The talk will also focus on the equivalence of bilipschitz and so-called *quasihomogeneous* parameterizations in certain settings. (Received December 27, 2011)

1079-30-119 **Javad Mashreghi*** (javad.mashreghi@mat.ulaval.ca), , Canada. *Composition of inner functions*.

If φ and ψ are inner functions, then we know that $\varphi \circ \psi$ is also an inner function (not a trivial fact). But, there is no reason to expect that $\varphi \circ \psi$ is a divisor of φ . In fact, there is some evidence to (wrongly) believe that this is not possible. For example, if φ and ψ are finite Blaschke products of orders m and $n \geq 2$, then $\varphi \circ \psi$ is a finite Blaschke product of order mn , and thus $\varphi \circ \psi$ cannot be a divisor of φ . However, we introduce a class of inner functions which fulfill this property. In particular, we give an explicit infinite Blaschke product B and an automorphism ψ such that $B \circ \psi$ is a subproduct of B . (Received January 03, 2012)

1079-30-131 **Albert Clop** (albertcp@mat.uab.cat), Departament de Matemàtiques, Universitat Autònoma de Barcelona, Facultat de Ciències, 08193 Barcelona, Catalonia, Spain, and **David A Herron*** (david.herron@uc.edu), Department of Mathematics, University of Cincinnati, PO Box 210025, Cincinnati, OH 45221-0025. *Hausdorff Measure and Mappings of Finite Distortion*. Preliminary report.

We examine mappings of finite distortion whose distortion functions belong to certain Lebesgue spaces, establish local modulus of continuity estimates for the inverses of such mappings, and describe the possible compression of Hausdorff measure under such mappings. We also exhibit examples that describe the extent to which our results are sharp. (Received January 06, 2012)

1079-30-143 **Irina Peterburgsky***, Department of Mathematics, Suffolk University, 8 Ashburton Place, Boston, MA 02108-277. *Existence and uniqueness of solutions to generalized extremal problems for operator of differentiation*.

In the present paper, we study a wide range of extremal problems for operator of differentiation over classes of analytic functions with Hilbert or Banach space codomain. We develop technique to describe existence and uniqueness of solutions to these problems in the terms of geometric properties of codomain space.

It has been shown that a number of classical propositions from traditional analysis allow for generalization in the case of Hilbert or Banach space of functions' codomain. These generalizations differ significantly, which is due to diversity of specific geometric properties of Banach spaces under consideration. (Received January 08, 2012)

1079-30-176 **Timothy Ferguson*** (timothy.j.ferguson@vanderbilt.edu), Department of Mathematics, 1326 Stevenson Center, Vanderbilt University, Nashville, TN 37240. *Bounds on integral means of Bergman projections*. Preliminary report.

We discuss a certain class of bounds for the integral means of the Bergman projections of functions in L^p spaces of the unit disc. These bounds generalize the result that the Bergman projection is bounded from L^p to the Bergman space A^p for $1 < p < \infty$. We also discuss applications of these bounds to regularity questions arising in the study of extremal problems. (Received January 11, 2012)

1079-30-255 **Stanislav Hencl** (henc1@karlin.mff.cuni.cz) and **Kai Rajala*** (kai.i.rajala@jyu.fi).
Optimal conditions for discreteness.

We discuss sharp extensions of Reshetnyak's theorem on discreteness and openness of quasiregular mappings. (Received January 16, 2012)

1079-30-272 **Tadeusz Iwaniec, Leonid V Kovalev** and **Jani Onninen*** (jkonnine@syr.edu), 215
 Carnegie Building, Syracuse University, Syracuse, NY 13244. *Hopf differentials and
 diffeomorphic approximation of Sobolev homeomorphisms.*

Every homeomorphism $h: X \rightarrow Y$ between planar open sets that belongs to the Sobolev class $W^{1,p}(X, Y)$, $1 < p < \infty$, can be approximated in the Sobolev norm by diffeomorphisms. As an application, we proved that every homeomorphism planar mapping with a holomorphic Hopf differential is harmonic. (Received January 16, 2012)

1079-30-282 **G Wang*** (gwang@math.fsu.edu), 208 Love Building, 1017 Academic Way, Tallahassee, FL
 32310, and **C A Nolder**. *Fourier Multipliers and Dirac Operators.*

We use Fourier multipliers of the Dirac operator and Cauchy transformation to obtain composition theorems and integral representations. In particular we calculate the multiplier of the Π -operator. This operator is the hypercomplex version of the beurling Ahlfors transform in the plane. The hypercomplex Beurling Ahlfors transform is a direct generalization of the Beurling Ahlfors transform and reduces to this operator in the plane. We give an integral representation for iterations of the hypercomplex Beurling Ahlfors transform and we present here a bound for the L^p norm. Such L^p bounds are essential for applications of the Beurling Ahlfors transform in the plane. The upper bound presented here is $m(p^* - 1)$ where m is the dimension of the Euclidean space on which the function is defined, $1 < p < \infty$ and $p^* = \max(p, \frac{p}{p-1})$. We use recent estimates on second order Riesz transforms to obtain this result. Using the Fourier multiplier of the Π operator we express this operator as a hypercomplex linear combination of second order Riesz transforms. (Received January 16, 2012)

1079-30-328 **Roger W. Barnard*** (roger.w.barnard@ttu.edu), Department of Mathematics &
 Statistics, Texas Tech University, Lubbock, TX 79409, **Alexander Yu. Solynin**
 (alex.solynin@ttu.edu), Department of Mathematics & Statistics, Texas Tech University,
 Lubbock, TX 79409, and **Matthew Lochman**, 10901 Little Patuxent Parkway, Columbia,
 MD 21044. *Iceberg-type Problems: Estimating Hidden Parts of a Continuum from the
 Visible Parts.*

We consider the complex plane \mathbb{C} as a space filled by two different media, separated by the real axis \mathbb{R} . We define $H+ = \{z : z > 0\}$ to be the upper half-plane. For a planar body E in \mathbb{C} , we discuss the problem of estimating characteristics of the "invisible" part, $E- = E \setminus H+$, from characteristics of the whole body E and its "visible" part, $E+ = E \cap H+$. In this talk we determine the maximal draft of E as a function of the logarithmic capacity of E and the area of $E+$. We then discuss the problem for the more naturally occurring domains that are convex and those with more general type boundaries. (Received January 17, 2012)

1079-30-360 **Arthur A. Danielyan*** (adaniely@usf.edu), Department of Mathematics and Statistics,
 University of South Florida, Tampa, FL. *On a polynomial approximation problem.*

Let F be an arbitrary closed subset on the unit circle T and let f be a continuous complex valued function on F . We consider the problem of uniform approximation of f on F by polynomials P_n (of variable z) which are uniformly bounded on T . In a particular case when F is a closed arc of T , this problem was solved by L. Zalcman in 1982. In this talk we give the solution of the problem in the general case. As an application of the main result we also present a new proof for the classical interpolation theorem due to W. Rudin and L. Carleson. (Received January 17, 2012)

1079-30-411 **Craig Allen Nolder*** (craiganolder@hotmail.com), Dept. of Math, Florida State
 university, Tallahassee, FL 32306. *Analysis in the Minkowski plane.*

We discuss the analytic function theory of solutions to the Dirac equation in the $\mathbb{R}^{1,1}$ -plane. The Minkowski plane can be seen as a two dimensional subspace of flat spacetime. Conformal mappings and their quasiconformal generalizations are also discussed. (Received January 18, 2012)

1079-30-427 **Ferenc Balogh*** (fbalogh@mathstat.concordia.ca), Department of Mathematics and Statistics, Concordia University, Montreal, Quebec, Canada. *Reduction of planar orthogonality to non-hermitian orthogonality on contours.*

The asymptotics of the orthogonal polynomials with respect to a deformed and scaled Bergmann-space scalar product are analysed in the scaling limit where both the order of polynomial and the scaling parameter go to infinity and their ratio $N=n$ is converging to a finite positive number. (Received January 18, 2012)

31 ► Potential theory

1079-31-39 **Vilmos Totik*** (totik@mail.usf.edu), 4202 E. Fowler Ave. PHY114, Tampa, FL 33620. *Contractions and absolutely continuous equilibrium measures.*

The class $L_0(H)$ of the so called cyclic quasianalytic contractions on a Hilbert space H contains a subclass $L_1(H)$ consisting of contractions whose quasianalytic spectral set covers the unit circle T . The contractions in $L_1(H)$ have rich invariant subspace lattices. We show that for every operator $T \in L_0(H)$ there exists an operator $T_1 \in L_1(H)$ commuting with T , so the hyperinvariant subspace problem for the two classes are equivalent. The operator T_1 is found as an H^∞ -function of T using the Sz.-Nagy-Foias calculus. The existence of an appropriate function (actually a suitable conformal map lying in the disk algebra) is proved using potential theoretic tools by constructing, within a given set of positive measure on T , a suitable regular compact set with absolutely continuous equilibrium measure. (Joint work with László Kérchy, University of Szeged) (Received November 29, 2011)

1079-31-346 **Alexander Yu. Solynin*** (alex.solynin@ttu.edu), Texas Tech University, Department of Mathematics and Statistics, Broadway and Boston, Lubbock, TX 79409-1042. *Reduced capacities and optimal shapes of droplets in the channel.* Preliminary report.

In this talk, we present some results obtained in collaboration with Mark Mineev-Weinstein (NMC, Los Alamos) and Giovanni Vasconcelos (Federal University of Pernambuco, Recife, Brasil) during our stay at the Institut Mittag-Leffler under the program “Complex Analysis and Integrable Systems”, Fall 2011. Let E be a compact set (called “droplets”) in the channel $S = \{z : |\Im z| < 1\}$. We will discuss different ways to define a capacity of E with respect to S . We also will give several sharp estimates of these capacities in terms of the area and some other geometric characteristics of droplets and discuss shapes of the extremal configurations. (Received January 17, 2012)

1079-31-400 **Charles Z. Martin*** (cmart07@math.ucsb.edu). *Elliptic Growth and Variation of the Green Function.*

An elliptic growth process associated to a differential operator L is one wherein a domain in \mathbb{C} grows due to outward pressure from its own Green function (associated to L). A natural inverse problem arises: given a ‘movie’ of a domain growing, is there an operator L for which the process is driven by elliptic growth? The Green function has a complex dependence upon its underlying domain and differential operator. A well-known formula due to Hadamard gives the first variation in the Green function when the domain is perturbed. In the same spirit, we can develop a first variation when the underlying operator—the Laplacian—is perturbed into a Schrödinger operator with a small potential. With formula in hand we can begin to study the inverse problem of elliptic growth. (Received January 18, 2012)

1079-31-423 **Nages Shanmugalingam*** (nages@math.uc.edu), University of Cincinnati, Dept. of Mathematical Sciences, P.O. Box 210025, Cincinnati, OH 45221. *The ∞ -Poincaré inequality on metric measure spaces.*

We study a geometric characterization of the ∞ -Poincaré inequality and show that a path-connected complete doubling metric measure space supports the ∞ -Poincaré inequality if and only if it is thick quasi-convex. (Received January 18, 2012)

32 ► *Several complex variables and analytic spaces*

1079-32-34 **Carmen Judith Vanegas*** (cvanegas@usb.ve). *General algebraic structures of Clifford type and Cauchy-Pompeiu Formulae for some piecewise constant structure relations.*

We show a generalization of Clifford algebras using other structure relations which possibly depend on spacelike variables. For piecewise constant structure relations we construct fundamental solutions explicitly and prove a Cauchy-Pompeiu Integral Formula.

This research was jointly carried out with Wolfgang Tutschke (Received November 25, 2011)

1079-32-186 **Nicholas A Sedlock*** (nsedlock@framingham.edu), 100 State Street, PO Box 9101, Framingham, MA 01701-9101. *Algebras of Truncated Toeplitz Operators.*

Truncated Toeplitz operators (TTOs) are compressed multiplication operators on backwards shift invariant subspaces (model spaces) of the Hardy space of the disc. A TTO A_Φ is multiplication by an H^2 function Φ followed by projection back to the given model space. These operators behave similarly, but not identically, to Toeplitz operators on the Hardy space. For example, two TTOs A_Φ and A_Ψ have another TTO as a product if and only if both A_Φ and A_Ψ belong to the same maximal commutative algebra \mathcal{B}^α in which case their product does as well. We will discuss these algebras in some detail, specifically the symbols, inverses and commutators of their elements. (Received January 12, 2012)

1079-32-303 **Matvei Libine*** (mlibine@indiana.edu). *The quaternionic cross-ratio and its properties.*

I will talk about a quaternionic analogue of the cross-ratio and its properties. For example, the quaternionic cross-ratio can be used to give a simple criterion for the existence of a quaternionic fractional linear transformation mapping one quadruple of points into another or one quintuple of points into another. The quaternionic cross-ratio can also be used to tell if given four points lie on a single circle (or a straight line) or if given five points lie on a single 2-sphere or (or a 2-plane).

As an application of the quaternionic cross-ratio we will show that the fractional linear transformations on the space of quaternions map spheres (or affine subspaces) of dimension 1, 2 and 3 into spheres (or affine subspaces) of the same dimension.

This is a joint work with an undergraduate student Ewain Gwynne. (Received January 17, 2012)

1079-32-425 **Marshall A Whittlesey*** (mwhittle@csusm.edu), Department of Mathematics, California State University San Marcos, San Marcos, CA 92096. *Construction of analytic graphs of complex dimension two in sets fibered over the ball.* Preliminary report.

Suppose that \mathbf{C} denotes the complex numbers and B_2 denotes the open unit ball in \mathbf{C}^2 . If Y is a compact set contained in $\partial B_2 \times \mathbf{C}^m$, let Y_z be the fiber of Y sitting over the point $z \in \partial B_2$. If $w_0 \in \mathbf{C}^m$, we discuss circumstances where there exists an analytic $f : B_2 \rightarrow \mathbf{C}^m$ extending smoothly to the boundary of the ball such that $f(0) = w_0$ and $f(z) \in \partial Y_z$ for all $z \in \partial B_2$. (Received January 18, 2012)

33 ► *Special functions*

1079-33-45 **Andrew Burruss*** (alburruss@gmail.com) and **Razvan Teodorescu.** *Normalization Conditions of an Elliptic Curve Construction.* Preliminary report.

An asymptotic description of the first Painleve transcendent uses a construction of an elliptic curve. We consider the normalization conditions on the given elliptic curve. In particular, the normalization condition defines a unique complex number which contributes to the equation of the curve and defines its cycles. (Received December 02, 2011)

1079-33-354 **Hisashi Ando** (h-ando@math.kyushu-u.ac.jp), Graduate School of Mathematics, Kyushu University, 744 Motooka, Nishi-ku, Fukuoka, 819-0395, Japan, **Mike Hay** (hay@math.kyushu-u.ac.jp), Institute of Mathematics for Industry, Kyushu University, 744 Motooka, Nishi-ku, Fukuoka, Fukuoka 819-0395, Japan, **Kenji Kajiwara*** (kaji@imi.kyushu-u.ac.jp), Institute of Mathematics for Industry, Kyushu University, 744 Motooka, Nishi-ku, Fukuoka, Fukuoka 819-0395, Japan, and **Tetsu Masuda** (masuda@gem.aoyama.ac.jp), Department of Mathematics and Physics, Aoyama Gakuin University, Sagamihara, Kanagawa 229-8558, Japan. *An explicit formula for the discrete power function associated with circle patterns of Schramm type.*

The discretization of complex analytic functions associated with the circle packings or circle patterns was initiated by Thurston in 1985. An important example is the discrete power function associated with the circle patterns of

Schramm type introduced by Bobenko in 1996. An interesting connection to the sixth Painlevé transcendent has also been pointed out by Agafonov and Bobenko. In this talk, we present an explicit formula for the discrete power function in terms of the hypergeometric τ functions of the sixth Painlevé equation, which are the determinants whose entries are given by the Gauss hypergeometric functions. We also consider some generalizations of the discrete power function based on this formula. (Received January 17, 2012)

1079-33-361 **Jonathan T Burns*** (jtburns@mail.usf.edu) and **Arcadii Z Grinshpan** (agrinsp@usf.edu). *Multiparameter binomial sums.*

We study a general sequence of binomial sums involving five real parameters. This sequence is generated by the combinatorial version of the Bernstein polynomial theorem. In the talk we show the asymptotic and monotonic properties of the sequence and discuss some examples and combinatorial applications. (Received January 17, 2012)

1079-33-432 **Emma Previato*** (ep@bu.edu), Department of Mathematics and Statistics, Boston University, Boston, MA 02215-2411. *Heat equations for the higher-genus sigma function.*

Riemann's ϑ -function is a fundamental heat solution:

$$\frac{\partial^2 \vartheta}{\partial z_i \partial z_j} = 2\pi i (1 + \delta_{ij}) \frac{\partial \vartheta}{\partial \tau_{ij}}.$$

Klein generalized Weierstrass' σ to a modular invariant, expandable in weighted abelian coordinates \vec{u} corresponding to jet bundles on the curve in its Jacobian. V.M. Bukhstaber and D.V. Leĭkin derived heat equations (HE) for σ w.r.t. parameters λ_j of the curve. In genus 2 they showed equivalence with physics equations as Chazy. With coauthors and current *Maple* program we produce the (\vec{u}, λ) HE satisfied by $\sigma(u_1, u_2, u_3)$ for the genus 3 curve $y^3 = x^4 + \lambda_3 x^3 + \lambda_2 x^2 + \lambda_1 x + \lambda_0$,

$$d_i \frac{\partial}{\partial \lambda_i} \sigma = \left[\sum_{j,k=1 \dots g} \left(a_j a_k u_j u_k + b_j^k u_j \frac{\partial}{\partial u_k} + c_{jk} \frac{\partial}{\partial u_j} \frac{\partial}{\partial u_k} \right) \right] \sigma,$$

$i = 0 \dots 3$, $d_i, a_{jk}, b_{jk}, c_{jk}$ polynomials in the λ_ℓ . We will discuss computational and theoretical challenges, as interpreting these equations in terms of the Gauss-Manin connection. (Received January 18, 2012)

34 ► Ordinary differential equations

1079-34-73 **Kristina Kraakmo*** (KKraakmo@knights.ucf.edu), Dept of Mathematics, MAP 207, University of Central Florida, Orlando, FL 32816, **Lei Ge** (GeGe@knights.ucf.edu), Department of Mathematics, MAP 207, Univ of Central Florida, Orlando, FL 32816, and **Roy Choudhury** (roy.choudhury141@gmail.com), Dept of Mathematics, MAP 207, University of Central Florida, Orlando, FL 32816. *Lax Pairs, Soliton Solutions and Dynamics for Integrable Coupled PT-Symmetric Cubic and Quartic Oscillators by the Extended Homogeneous Balance Method.*

We derive Lax Pairs and soliton solutions for the integrable cases of general coupled, PT-Symmetric, cubic and quartic oscillators in the plane by the extended homogeneous balance method. For the quartic case, the Lax Pair results automatically, while its derivation is more tricky in the cubic case. The analysis also yields a method for recovering the integrable parameter sets, originally identified by Painlevé analysis, as the necessary conditions for existence of a Lax pair with a spectral parameter. Soliton solutions are also derived via iterations of the original truncated homogeneous balance expansion for the solutions. Finally, we also compare and contrast the phase-space dynamics of the solutions for various integrable and non-integrable parameter sets. (Received December 16, 2011)

1079-34-120 **jagdish chandra*** (jchandra@gwu.edu) and **G S Ladde**. *Dynamic stochastic models of Social Networks*. Preliminary report.

We construct dynamic social network models as a group of decision makers. Consider multiple agents situated at dynamic nodes of a network, each agent having a finite set of characteristics, interacting in a dynamic way based on affinity or commonality of interests. Consider also an environment where both the nodes (agents) and their interactions change with time. We model this dual dynamics by coupled systems of differential equations. In the first level of complexity, modeled by deterministic equations, the characteristics of the individual agent evolve and change only driven by their interactions, without the addition of external noise. This work is then extended to include external (environmental) disturbances or change in the topology of networks. The description of this requires appropriate set of stochastic differential equations. In all these cases our goal is to extract qualitative features such as regions of coherence and stability of such collaboration. We employ

appropriate energy (Liapunov-like) functions to establish properties such as coherence, stability, and robustness of cooperation. (Received January 03, 2012)

1079-34-122 **Matthew Bledsoe*** (bledsoem@uab.edu), Dept. of Mathematics, Campbell Hall, 1300 University Blvd., Birmingham, AL 35294. *Stability of the inverse resonance problem on the line.*

In the absence of a half-bound state, a compactly supported potential of a Schrödinger operator on the line is determined, up to a translation, by the zeros and poles of the meromorphically continued left (or right) reflection coefficient. The poles are the eigenvalues and resonances, while the zeros are also physically relevant. We prove that all compactly supported potentials (without half-bound states) that have reflection coefficients whose zeros and poles are ε -close in some disk centered at the origin are also close (in a suitable sense). In addition, we prove stability of small perturbations of the zero potential (which has a half-bound state) from only the eigenvalues and resonances of the perturbation. (Received January 03, 2012)

1079-34-159 **Robert Buckingham*** (buckinrt@uc.edu), Department of Mathematics, University of Cincinnati, Cincinnati, OH 45221, and **Peter Miller.** *Asymptotics of rational Painleve II solutions.*

The nonhomogenous Painleve II equation has exactly one rational solution for specific values of the nonhomogeneity parameter α . Clarkson and Mansfield observed that the zeros (or poles) of these rational solutions appear to have a highly regular triangular structure. We prove that, in the large- α limit, the scaled zeros (or poles) fill out a certain curvilinear triangular region in the complex plane. We also discuss progress on computing the leading-order asymptotic behavior of the rational solutions inside, outside, and at the edge of this root region. (Received January 10, 2012)

1079-34-389 **Tadesse G. Zerihun*** (tzerihun@mail.usf.edu), Department of Mathematics and Statistics, University of South Florida, 4202 East Fowler Avenue, PHY 114, Tampa, FL 33620-5700, and **Gangaram S Ladde** (gladde@usf.edu), Department of Mathematics and Statistics, University of South Florida, 4202 East Fowler Avenue, PHY 114, Tampa, FL 33620-5700. *Method of Variation of Parameters and Nonlinear Stochastic Perturbed System of Differential equations.* Preliminary report.

By decomposing a nonlinear stochastic perturbed system of differential equations into nonlinear systems of stochastic unperturbed and perturbation differential equations, we establish the fundamental properties of solutions of nonlinear stochastic unperturbed system of differential equations. Using these properties, we find the representation of solution process of nonlinear stochastic perturbed system of differential equations in terms of solution process of nonlinear stochastic unperturbed system of differential equations. (Received January 18, 2012)

1079-34-397 **Milivoje Lukic*** (milivoje.lukic@rice.edu), Rice University, Mathematics MS 136, 6100 Main Street, Houston, TX 77030. *Schrödinger operators with decaying oscillatory potentials.*

We consider a class of Schrödinger operators with oscillatory potentials obeying an L^p decay condition. This class of potentials includes slowly decaying Wigner-von Neumann type potentials $\sin(ax)/x^b$ with $b > 0$. We prove absence of singular continuous spectrum and show that embedded eigenvalues in the continuous spectrum can only take values from an explicit finite set. Conversely, we construct examples where such embedded eigenvalues are present. (Received January 18, 2012)

35 ► *Partial differential equations*

1079-35-50 **Wen-Xiu Ma*** (mawx@cas.usf.edu), 4202 E Fowler Avenue, Tampa, FL 33620. *Hirota bilinear equations, Bell binary polynomials and the linear superposition principle.* Preliminary report.

We will discuss when Hirota bilinear equations possess the linear superposition principle, and explore basic relationships between Hirota bilinear equations and linear subspaces of solutions. A sort of resonance of different waves is the starting point to formulate linear subspaces of solutions for nonlinear differential equations. (Received December 10, 2011)

1079-35-62 **Zhijun (George) Qiao*** (qiao@utpa.edu), 1201 W Univ Dr, Edinburg, TX 78539-2999. *Negative KdV equation with solitons and kink wave solutions.* Preliminary report.

In this talk, we report an interesting integrable equation that has both solitons and kink solutions. The integrable equation we study is derived from the negative KdV hierarchy and could be transformed to the Camassa-Holm

equation through a gauge transform. The Lax pair of the equation is derived to guarantee its integrability, and furthermore the equation is shown to have classical solitons, periodic soliton and kink solutions (Received December 13, 2011)

1079-35-69 **Hossein Jafari*** (jafari@umz.ac.ir), Department of Mathematics, University of Mazandaran, 474169544 Babolsar, Mazandaran, Iran, and **C M Khalique** and **N Kakhoda**. *Lie symmetry approach and simplest equation method for solving Boussinesq equations*. Preliminary report.

This paper obtains the exact solutions of the Bad Boussinesq and Good Boussinesq equations. The Lie symmetry approach and simplest equation method is used to obtain these solutions. As the simplest equation, we have used the equation of Riccati. (Received December 16, 2011)

1079-35-72 **Roy Choudhury*** (roy.choudhury141@gmail.com), Dept of Mathematics, MAP 207, University of Central Florida, Orlando, FL 32816. *Bridging the Homogeneous Balance and Painlevé Singularity Manifold Methods to Algorithmically Generate Lax Pairs of Integrable PDEs*.

We demonstrate a technique for algorithmically obtaining the Lax Pair for an integrable nonlinear PDE (or NLPDE). The method involves an artful application (borrowed from the Homogeneous Balance Method) of a logarithmic transformation to the Painlevé-Backlund equations resulting from applying Weiss' Singularity Manifold Method (SMM) to the original NLPDE. Several problems are thereby circumvented. In particular, linearization and introduction of a spectral parameter, both of which are tricky in the original SMM, occur algorithmically. Another feature is the telescoping of all singular terms in Weiss' truncated expansion into a single term, a feature which may be considered to be a version of what Painlevé termed a 'singular part transformation'. The only restriction of this technique is that it may currently be applied to NLPDEs with one Painlevé singularity manifold. Future work will attempt to remove this limitation. (Received December 16, 2011)

1079-35-75 **Keri Hagerman*** (khagerman@knights.ucf.edu), Dept of Mathematics, MAP 207, University of Central Florida, Orlando, FL 32816, and **Roy Choudhury** (roy.choudhury141@gmail.com), Dept of Mathematics, MAP 207, University of Central Florida, Orlando, FL. *A New Integrable PT-Symmetric Hierarchy of KdV Equations*.

We generalize the work of Bender and co-workers to derive a new integrable hierarchy of PT-symmetric KdV equations. The possible integrable members are identified employing the Painlevé Test, and are indexed by the integer n , corresponding to the negative of the order of the dominant pole in the singular part of the Painlevé expansion for the solution. As with some other hierarchies, the first or $n=1$ equation proves non-integrable, the $n=2$ member corresponds to the regular KdV equation, while the remainder form an entirely new hierarchy. Integrability properties of the $n=3$ and $n=4$ members, including Backlund Transformations, Lax Pairs, and soliton solutions are derived. The solitons prove to be algebraic in form, and the extended homogeneous balance technique appears to be the most efficient in exposing the Lax Pair. In particular, it proves both easier and more algorithmic than other competing techniques such as direct integration and linearization of the Painlevé-Backlund equations, or use of recent procedures based on Bell polynomials. (Received December 16, 2011)

1079-35-84 **Kazuo Yamazaki*** (kyamazaki@math.okstate.edu), Department of Mathematics, Oklahoma State University, 401 Mathematical Sciences, Stillwater, OK 74078. *Recent results on global regularity issues of Navier-Stokes type models: a review*.

Global regularity issue of the Navier-Stokes system remains one of the most challenging outstanding open problems in analysis and partial differential equations. In the past decade, we have seen great progress in related models, in particular the classical Leray-alpha type and active scalars such as quasi-geostrophic equation. We will review some recent results on these equations: dissipation term replaced via fractional Laplacian, global regularity with smoothed velocity, well-posedness in Besov space, dissipation term only partially in different directions, anisotropic regularity criteria. We will also discuss new result concerning the global regularity of Navier-Stokes system with velocity filtration. (Received December 20, 2011)

1079-35-90 **Muhammad Usman*** (musman1@udayton.edu), 300 College Park, Dayton, OH 45469-2316. *Qualitative Study of Some Nonlinear Partial Differential Equations Using CAS*. Preliminary report.

In this talk some results on bifurcations in steady state solutions of a class of nonlinear dispersive wave equation and for a damped externally excited Kuramoto-Sivashinsky Equation will be presented. Using an asymptotic perturbation method stability of solutions will be discussed. We consider the primary resonance by defining the detuning parameter. External-excitation and frequency-response curves are shown to exhibit jump and hysteresis

phenomena (discontinuous transitions between two stable solutions) for the models. (Received December 24, 2011)

1079-35-93 **Wen-Xiu Ma** and **Junyi Tu*** (junyi@mail.usf.edu), Tampa, FL 33613. *Hirota bilinear equations possessing linear superposition principles of exponential waves*. Preliminary report.

We explore when Hirota bilinear equations possess the linear superposition principle of exponential traveling waves. In particular, we show that multivariate polynomials whose zeros form a vector space generate such Hirota bilinear equations. We formulate the required multivariate polynomials by using multivariate polynomials which have one and only one zero. Applying an algorithm involving weights, a few illustrative examples are given. (Received December 24, 2011)

1079-35-107 **Omer Unsal*** (ounsal@ogu.edu.tr), Eskisehir Osmangazi University, Art-Science Faculty, Mathematics and Computer Science Department, 26480 Eskisehir, Turkey, **Mehmet Naci Ozer** (mnozer@ogu.edu.tr), Eskisehir Osmangazi University, Art-Science Faculty, Mathematics and Computer Science Department, 26480 Eskisehir, Turkey, and **Ahmet Bekir** (abekir@ogu.edu.tr), Eskisehir Osmangazi University, Art-Science Faculty, Mathematics and Computer Science Department, 26480 Eskisehir, Turkey. *New exact solutions to some nonlinear evolution equations by using first integral method*.

In this paper, we show the applicability of the first integral method to Pochhammer-Chree equation and Bogoyavlenskii equations. Nonlinear evolution equations are separately reduced to nonlinear ordinary differential equations (ODE) by using a simple transformation. With the aid of Maple, new exact solutions of two selected nonlinear equations are derived. As a result, the power of the employed method is confirmed. This approach can also be applied to other nonlinear evolution equations used in applied mathematics and physics. (Received January 02, 2012)

1079-35-108 **Mehmet Naci Ozer** (mnozer@ogu.edu.tr), Eskisehir Osmangazi University, Art-Science Faculty, Mathematics and Computer Science Department, 26480 Eskisehir, Turkey, **Ahmet Bekir*** (abekir@ogu.edu.tr), Eskisehir Osmangazi University, Art-Science Faculty, Mathematics and Computer Science Department, 26480 Eskisehir, Turkey, and **Burcu Ayhan** (burcu_ayhan87@hotmail.com), Eskisehir Osmangazi University, Art-Science Faculty, Mathematics and Computer Science Department, 26480 Eskisehir, Turkey. *Exact solutions of nonlinear evolution equation systems*.

In this paper, we investigate two systems nonlinear evolution equations of involving parameters by applying the (G'/G) -expansion method for constructing some new exact traveling wave solutions including solitons and periodic solutions. The second order linear ordinary differential equation with constant coefficients is used as a auxiliary equation in the method. The obtained solutions are presented through the hyperbolic, the trigonometric and the rational functions. It is significant to point out that some of our solutions are in good agreement for special cases with the existing results which validates our other solutions. The method is straightforward and concise, and it holds promise for many applications. (Received January 02, 2012)

1079-35-109 **Mehmet Naci Ozer** (mnozer@ogu.edu.tr), Eskişehir Osmangazi University, Art and Science Faculty, Mathematics and Computer Science Department, 26480 Eskisehir, Turkey, and **Murat Koparan*** (mkoparan@anadolü.edu.tr), Anadolu University, Education Faculty, Department of Elementary Education, 26470 Eskisehir, Turkey. *Derivation of integrable equations from nonlinear partial equations by multiple scales methods*.

In this work, we obtained integrable KdV type evolution equations with their solitary-wave solutions and integrability conditions by applying the multiple scales method from some wave equations known as nonlinear evolution equations. In addition, through using a different multiple scales method including higher order slow variables, KdV type evolution equations were derived from integrable nonlinear Schrödinger type equations. For the multiple scales calculations REDUCE computer algebraic packet program is used. (Received January 02, 2012)

1079-35-115 **Sergey Morozov**, **Leonid Parnovski** and **Roman Shterenberg*** (rshterenberg@gmail.com), Department of Mathematics, University of Alabama at Birmingham, 1300 University Blvd., Birmingham, AL 35216. *Complete asymptotic expansion of the integrated density of states of multi-dimensional almost-periodic pseudo-differential operators*. Preliminary report.

We find the complete asymptotic expansion of the integrated density of states of operators of the form $H = (-\Delta)^w + B$ in \mathbb{R}^d . Here $w > 0$ and B is an almost-periodic self-adjoint pseudo-differential operator of order less

than $2w$. We assume that for high momenta the symbol of B can be approximated by a sum of homogeneous functions of the momenta. (Received January 03, 2012)

1079-35-116 **Ugur G Abdulla*** (abdulla@fit.edu), 150 West Univ Blvd, Melbourne, FL 32901, and **Ogugua Onyejekwe** (onyejek@fit.edu), Melbourne, FL 32901. *On the Inverse Stefan Problem.*

We develop a new variational formulation of the inverse Stefan problem, where information on the heat flux on the fixed boundary is missing and must be found along with the temperature and free boundary. We employ optimal control framework, where boundary heat flux and free boundary are components of the control vector, and optimality criteria consists of the minimization of the sum of L_2 -norm deviations from the available measurement of the temperature flux on the fixed boundary and available information on the phase transition temperature on the free boundary. This approach allows one to tackle situations when the phase transition temperature is not known explicitly, and is available through measurement with possible error. It also allows for the development of iterative numerical methods of least computational cost due to the fact that for every given control vector, the parabolic PDE is solved in a fixed region instead of full free boundary problem. We prove well-posedness in Sobolev spaces framework, Frechet differentiability and convergence of discrete optimal control problems to the original problem both with respect to cost functional and control. (Received January 03, 2012)

1079-35-117 **Ugur G Abdulla*** (abdulla@fit.edu), 150 West Univ Blvd, Melbourne, FL 32901. *Wiener test for the Regularity of ∞ for Elliptic Equations with Measurable Coefficients and Its Consequences.*

We introduce a notion of regularity (or irregularity) of the point at infinity (∞) for the unbounded open set $\Omega \subset R^N$ concerning second order uniformly elliptic equations with bounded and measurable coefficients, according as whether the \mathcal{A} -harmonic measure of ∞ is zero (or positive). A necessary and sufficient condition for the existence of a unique bounded solution to the Dirichlet problem in an arbitrary open set of R^N , $N \geq 3$ is established in terms of the Wiener test for the regularity of ∞ . It coincides with the Wiener test for the regularity of ∞ in the case of Laplace equation. From the topological point of view, the Wiener test at ∞ presents thinness criteria of sets near ∞ in fine topology. Precisely, the open set is a deleted neighborhood of ∞ in fine topology if and only if ∞ is irregular. (Received January 03, 2012)

1079-35-125 **Daniel T Onofrei*** (onofrei@math.uh.edu) and **Kui Ren**. *Active manipulation of acoustic fields and applications.*

The idea of active manipulation of fields initially originated in the works of Guevara Vasquez, Milton and Onofrei for the problem of acoustic cloaking.

In this talk we will show that the cloaking problem studied before is a particular case of a more general first kind integral equation and we will study this new general problem. We will discuss about the existence of solutions, stability of the associated minimal energy solution and the possibility to control the near field of the minimum energy solution. (Received January 04, 2012)

1079-35-163 **Santosh Bhattarai***, Department of Mathematics, 601 Elm Ave, Norman, OK 73019, and **John Albert**, Department of Mathematics, 601 Elm Ave, Norman, OK 73019. *Concentration compactness and the stability of solitary wave-solutions for a Schrodinger-KdV system.*

The coupled Schrodinger-Kortweg-de Vries systems appear in fluid mechanics as models for interactions between short-wavelength oscillatory nonlinear waves and long nonlinear waves. These systems also appear in plasma physics modeling the interaction of the Langmuir and ion-acoustic waves. In this talk, we introduce the sets of solitary waves for a NLS-KdV system and we show that they are stable provided the associated action is strictly convex. The existence of solitary waves can be proved by using Lions' concentration compactness principle. The result is related to recent work of J. A. Pava and of J. P. Dias, M. Figueira and F. Oliveira. (Received January 10, 2012)

1079-35-171 **Alrazi M Abdeljabbar*** (alrazia@yahoo.com), Department of Mathematics & Statistic, 4202 East Fowler Ave, PHY114, Tampa, FL 33620. *Determinant Solutions to Nonlinear Partial Differential Equations.*

We are going to discuss three kind of exact solutions: Wronskian, Grammian and Pfaffian solutions. Two examples will be considered: (3+1)-dimensional Jimbo-Miwa equation and (2+1)-dimensional generalized Boussinesq system with variable coefficient (Received January 11, 2012)

1079-35-177 **Magdy G Asaad*** (mgamil@mail.usf.edu), 13373 Arbor pointe circle, apt 102, Tampa, FL 33617. *Applications of the Pfaffian technique to three (3+1)-dimensional soliton equations of Jimbo-Miwa type and their bilinear Bäcklund transformations.*

A class of exact Pfaffian solutions to three (3+1)-dimensional soliton equations of Jimbo-Miwa type is obtained. A set of sufficient conditions consisting of systems of linear partial differential equations involving free parameters is generated to guarantee that the Pfaffian solves the equations. A Bäcklund transformations of the equations are presented. The equations are transformed into a set of bilinear equations, and a few classes of traveling wave solutions, rational solutions and Pfaffian solutions to the extended bilinear equations are furnished. Examples of the Pfaffian solutions are explicitly computed, and a few solutions are plotted. (Received January 11, 2012)

1079-35-188 **Jean Dolbeault, Maria J Esteban and Michael Loss*** (loss@math.gatech.edu), School of Mathematics, Georgia Tech, 686 Cherry Street, Atlanta, GA 30332-0160. *Symmetry results for Caffarelli-Kohn-Nirenberg inequalities.*

The Caffarelli-Kohn-Nirenberg inequalities in space dimension $N \geq 2$ can be written as

$$\left(\int_{\mathbb{R}^N} \frac{|w(x)|^p}{|x|^{bp}} dx \right)^{2/p} \leq C_{a,b}^N \int_{\mathbb{R}^N} \frac{|\nabla w(x)|^2}{|x|^{2a}} dx$$

for suitable parameters a, b, p . This talk is concerned with new symmetry results for the extremals of these inequalities in a range of parameters for which no explicit results of symmetry have previously been known. The method proceeds via spectral estimates. (Received January 12, 2012)

1079-35-192 **Baofeng Feng*** (feng@utpa.edu). *An integrable coupled short pulse equation.*

An integrable coupled short pulse (CSP) equation is proposed for the propagation of ultra-short pulses in optical fibers. Based on two sets of bilinear equations to two-dimensional Toda-lattice (2DTL) linked by a Bäcklund transformation, and an appropriate hodograph transformation, the proposed CSP equation is derived. Meanwhile, its N -soliton solutions are given by Casorati determinant in parametric form. The properties of one- and two-soliton solutions are investigated in detail. Same as the short pulse equation, two-soliton solution turns out to be a breather type if the wave numbers are complex conjugate. We also illustrate an examples of soliton-breather interaction. (Received January 12, 2012)

1079-35-207 **Venkataram Vanaja*** (vvanaja2@usf.edu). *Exact Solutions of a Nonlinear Diffusion-convection Equation.*

Symbolic methods are used to obtain travelling-wave solutions of the equation $\frac{\partial u}{\partial t} = \frac{\partial(u^n)}{\partial x} + \frac{\partial^2(u^m)}{\partial x^2}$, where n and m are integers, and $n \geq m > 1$. This equation models the flow of water under gravity through a homogeneous and isotropic porous medium. For certain values of n and m satisfying the given condition, analytical solutions of the equation as a polynomial in $\tan(x)$ or $\tanh(x)$, with integral or fractional powers are obtained, and the plots for real solutions are given. From the exact solutions, we determine whether the moisture content is positive and the seepage velocity is continuous. (Received January 13, 2012)

1079-35-231 **Dhanapati Adhikari, Chongsheng Cao and Jiahong Wu*** (jiahong@math.okstate.edu), 401 Math Sciences, Oklahoma State University, Stillwater, OK 74078. *The 2D incompressible Boussinesq equations with vertical dissipation.*

The Boussinesq equations concerned here model many geophysical flows such as atmospheric fronts and ocean circulations. Mathematically the 2D Boussinesq equations serve as a lower-dimensional model of the 3D hydrodynamics equations. In fact, the 2D Boussinesq equations retain some key features of the 3D Euler and Navier-Stokes equations such as the vortex stretching mechanism. In the last few years the global regularity problem on the 2D Boussinesq equations with partial dissipation has attracted considerable attention. The global regularity problem for the 2D anisotropic Boussinesq equations with only vertical dissipation is very challenging due to the lack of control on the horizontal derivatives. This talk reports some very recent work asserting the global (in time) regularity of classical solutions to the 2D anisotropic Boussinesq equations with only vertical dissipation. (Received January 15, 2012)

1079-35-232 **Garrett J Rea***, 1110 N. Cory #H, Findlay, OH 45840. *A Harnack Inequality and Hölder Continuity for Weak Solutions to a Quasi-linear Parabolic Operator Involving Hörmander Vector Fields.*

In 1964, Jürgen Moser proved a Harnack inequality and Hölder continuity for weak solutions to certain parabolic operators in \mathbb{R}^n . Since then, his approach has been adapted to many situations. We employ his iteration scheme

to show a parabolic Harnack inequality and Hölder continuity of weak solutions of nonlinear parabolic operators of the form

$$Lu = u_t + \sum_{j=1}^m X_j^* A(x, \nabla_0 u) = 0.$$

Here $u \in S_{loc}^{1,2}(\mathbb{R}^{n+1})$, $\{X_i\}_{i=1}^m$ are smooth vector fields satisfying Hörmander's condition, X_j^* is the formal adjoint of X_j and $A : \mathbb{R}^m \rightarrow \mathbb{R}^m$ is a measurable function. (Received January 15, 2012)

1079-35-238 **Hongjie Dong*** (Hongjie_Dong@brown.edu), 182 George Street, Providence, RI 02912, and **Doyoon Kim**. *Lp and Schauder estimates for a class of non-local elliptic equations.*

I will discuss some recent results about Lp and Schauder estimates for a class of non-local elliptic equations which are associated to pure jump Levy processes. Compared to previous known results, the novelty of our results is that the kernels of the operators are not necessarily to be homogeneous, regular, or symmetric. (Received January 15, 2012)

1079-35-241 **Aghalaya S Vatsala*** (Vatsala@Louisiana.edu), Department of Mathematics, Univ. of Louisiana at Lafayette, Lafayette, LA 70504 1010, and **Donna Sue Stutson**.

Representation Form for One Dimensional Caputo Fractional Wave Equation and Comparison Results. Preliminary report.

It is well known that fractional Brownian motion has been modeled as parabolic stochastic differential equation. In this work we develop a representation form for the solution of the deterministic one dimensional fractional wave equation with Caputo fractional derivative of order q , for $1 < q < 2$. For $q = 1$, and $q = 2$, it reduces to the one dimensional parabolic equation and one dimensional wave equation respectively. We will develop some comparison results which will be useful in the study of nonlinear fractional wave equation. (Received January 16, 2012)

1079-35-259 **Jinghan Meng*** (jmeng@mail.usf.edu), University of South Florida, Department of Math and Statistics, 4202 East Fowler Ave, TAMPA, FL 33620, and **Wen-Xiu Ma** (wma3@usf.edu), University of South Florida, Department of Math and Statistics, 4202 East Fowler Ave, TAMPA, FL 33620. *Bi-integrable couplings of the Kaup-Newell hierarchy.*

In this talk, we will present our recent research on bi-integrable couplings of soliton equations. An application of the presented non-semisimple Lie algebra gives bi-integrable couplings of the Kaup-Newell hierarchy. Hamiltonian structures will be generated to guarantee existence of infinitely many commuting symmetries and conserved quantities. (Received January 16, 2012)

1079-35-267 **Thomas Bieske** (tbieske@usf.edu), University of South Florida, Dept. of Mathematics and Statistics, 4202 E. Fowler Ave., PHY 114, Tampa, FL 33620, and **Kristen Childers*** (kchilders244@gmail.com), University of South Florida, Dept. of Mathematics and Statistics, 4202 E. Fowler Ave. PHY 114, Tampa, FL 33620. *Generalizations of a Laplacian-type Equation in the Heisenberg Group and a Class of Grushin-type Spaces.*

Beals, Gaveau and Greiner (1996) find the fundamental solution to a 2-Laplace-type equation in a class of sub-Riemannian spaces. This solution is related to the well-known fundamental solution to the p-Laplace equation in Grushin-type spaces (Bieske-Gong, 2006) and the Heisenberg group (Capogna, Danielli, Garofalo, 1997). We extend the 2-Laplace-type equation to a p-Laplace-type equation. We show that the obvious generalization does not have desired properties, but rather, our generalization preserves some natural properties. (Received January 18, 2012)

1079-35-276 **Heather Griffin*** (hgriffi@uark.edu). *Pointwise Schauder Estimates of Parabolic Equations in Carnot Groups.* Preliminary report.

The goal of this talk is to establish pointwise Schauder estimates for second order parabolic equations of the form

$$\partial_t u(x, t) - \sum_{i,j=1}^{m_1} a_{ij}(x, t) X_i X_j u(x, t) = f(x, t)$$

where X_1, \dots, X_{m_1} generate the first layer of the Lie algebra stratification for a Carnot group. We will begin with a quick introduction to Carnot groups and Taylor polynomials with horizontal vector fields. Using some geometric properties of the parabolic setting and by comparing solutions to their Taylor polynomials, the proof for the estimates will be discussed. (Received January 16, 2012)

1079-35-280 **Bingyu Zhang*** (zhangb@ucmail.uc.edu), Department of Mathematical Sciences, University of Cincinnati, Cincinnati, OH 45221-0025. *Sharp Trace Theorems for Solutions of Dispersive Wave Equations and Their Applications*. Preliminary report.

In this talk, we will present several sharp trace theorems for solutions of dispersive wave equations and will explain how those sharp trace theorems play important roles in analysis and control of dispersive wave equations. (Received January 16, 2012)

1079-35-281 **Vita Borovyk*** (vita.borovyk@uc.edu) and **Michael Goldberg**. *Dispersive Estimates in Harmonic Lattice Systems in dimension 2*.

We consider infinite-volume quantum lattice systems and study the decay of the commutators of observables with time-dependent supports in the large-time regime. For simplicity, we assume that one observable is supported at the origin, while the other one is moving, and study the dependence of the decay rate of the commutator on the velocity of the moving observable. Specifically, we investigate the relation between that velocity and the degeneracy of the corresponding phase function using a representation of the commutator in terms of oscillatory integrals. An asymptotic analysis of these integrals yields a classification of velocities according to the dispersion rates they produce. In particular, we show that in dimension 2 there exists a unique velocity (up to mirror symmetries) that produces a minimal dispersion rate of the order $|t|^{-3/4}$. (Received January 16, 2012)

1079-35-296 **Mimi Dai*** (mdai@slugmail.ucsc.edu), **Jie Qing** and **Maria Schonbek**. *Asymptotic Behavior of Solutions to the Liquid Crystal Systems in \mathbb{R}^3* .

In this paper we study the asymptotic behavior for solutions to a nematic liquid crystals system in the whole space \mathbb{R}^3 . The fluid under consideration has constant density and small initial data. The main ingredient to derive decay is Fourier splitting method which was originally introduced by M. Schonbek to study the large time behavior of solutions to Navier-Stokes equations. The asymptotic behavior of solutions to systems of nematic liquid crystals, on bounded domains with constant fluid density has been studied by several other authors using different methods. (Received January 17, 2012)

1079-35-316 **Paula Cerejeiras*** (pceres@ua.pt), Department of Mathematics, University of Aveiro, 3810-193 Aveiro, Portugal. *Lax pairs and Dirac analysis*.

Lax pairs are a well-established tool for the study of in-stationary nonlinear PDE's. Given a pair of linear operators acting on a certain Hilbert space we will say that they form a Lax pair for an in-stationary nonlinear PDE if that PDE arises as a compatibility condition between the two given operators. Since Lax pairs are closely linked to spectral decompositions they are not easily obtainable in the context of Dirac operators due to the non-commutativity of the underlying algebraic structure. In this talk we construct Lax pairs using the Dirac operator in the context of Clifford analysis. We hope to demonstrate that it is possible to obtain Lax pairs for linear differential operators with polynomially generalized Dirac operators and also give an example for a non-linear PDE. The main idea here is to substitute the classic approach by the so-called AKNS method. (Received January 17, 2012)

1079-35-338 **Necibe Tuncer***, necibe-tuncer@utulsa.edu. *Radially Projected Finite Elements for Pattern Formation on Spheroidal Surfaces*. Preliminary report.

We develop and analyze a numerical method to approximate solutions of reaction diffusion systems defined on arbitrary surfaces. In particular, we are interested in reaction diffusion systems that model pattern formation on arbitrary surfaces. Such systems have numerous applications; examples include patterns on seashells and tropical fish, and butterfly wing pigmentation. The method we propose is based on radially projected finite elements. The power of the numerical method is that it is easy to implement, and all computations are done in logically rectangular coordinates. (Received January 17, 2012)

1079-35-352 **Yulia Karpeshina*** (karpeshi@uab.edu) and **Roman Shterenberg** (shterenb@uab.edu). *Multiscale Analysis in Momentum Space for Quasi-periodic Potential in Dimension Two*. Preliminary report.

We consider a polyharmonic operator $H = (-\Delta)^l + V(x)$ in dimension two with $l \geq 2$, l being an integer, and a quasi-periodic potential $V(x)$. We prove that the spectrum of H contains a semiaxis and there is a family of generalized eigenfunctions at every point of this semiaxis with the following properties. First, the eigenfunctions are close to plane waves $e^{i(\vec{k}, \vec{x})}$ at the high energy region. Second, the isoenergetic curves in the space of momenta \vec{k} corresponding to these eigenfunctions have a form of slightly distorted circles with holes (Cantor type structure). A new method of multiscale analysis in the momentum space is developed to prove these results. (Received January 17, 2012)

1079-35-413 **Xiaosheng Li*** (xli@fiu.edu), Department of Mathematics and Statistics, Florida International University, Miami, FL 33199. *Inverse problems with partial data in unbounded domains.*

The inverse boundary value problems consist of recovery of the coefficients of the partial differential equations in a domain from measurements of the solutions on its boundary. Recently, the inverse problems with incomplete data, where the measurements are made on only part of the boundary, have received many attentions. In this talk we survey the recent developments on such problems in unbounded domains, particularly, in a half space and in an infinite slab. (Received January 18, 2012)

1079-35-415 **Sunnie Joshi*** (sjoshi@math.tamu.edu), Department of Mathematics, Texas A&M University, College Station, TX 77843, and **Abner J. Salgado**. *Estimating Physical Parameters of Soft Tissues Using Inverse Spectral Theory.*

Inverse problems arise in many areas of science and mathematics, including geophysics, astronomy, acoustic tomography and medical biology. Inverse Sturm-Liouville problems (SLP) is a branch of inverse problems that has applications in most of these areas and have been studied since the early 1900s. Our motivation for studying such problems comes from an application in biomechanics, particularly in estimating material parameters for soft tissues. In this talk, we will propose a constructive numerical algorithm based on finite element methods to recover the potential for a SLP using least squares formulation. Some theoretical analysis will be presented along with some numerical results to show the availability of the method. (Received January 18, 2012)

1079-35-422 **Erin Haller Martin*** (erin.martin@westminster-mo.edu) and **Thomas Bieske** (tbieske@math.usf.edu). *On the Parabolic p -Laplace and Infinite Laplace Equations in Carnot Groups.*

We will show the existence and, via a parabolic maximum principle, uniqueness of viscosity solutions to the parabolic p -Laplace and parabolic infinite Laplace equations in Carnot groups. We will then examine the limits as t and p go to infinity. (Received January 18, 2012)

1079-35-428 **Mark Mineev-Weinstein*** (mark_mw@hotmail.com), NMC, Los Alamos, and MPIPKS, Dresden. *New class of exact solutions and bubble selection in a Hele-Shaw Cell.*

Pattern formation selection problems (far from equilibrium) was a long-standing challenge in theoretical physics and applied mathematics since 1950s, when pioneering experiments of Sir G.I. Taylor were conducted. The main problem was the absence of conventional mathematical tools to describe dynamics in unstable environment. In 1980s the pattern selection was resolved via the surface tension by using the “Asymptotic beyond all orders” (M. Kruskal and H. Segur, 1983), which was based on a quasiclassical technique, developed in 1960s by Pokrovsky and Khalatnikov for an electron reflection above a potential barrier.

In this talk I will report new class of solutions recently obtained with G.L. Vasconcelos (UF Pernambuco, Brazil) in a problem of a velocity and shape selection of Taylor-Saffman bubble from a continuous family of admissible solutions without using surface tension. The results are in a full agreement with experiments. This results were possible to obtain due to a remarkable and powerful integrable structure of the non-linear interface dynamics equations, which we (and others) have developed earlier. (Received January 18, 2012)

37 ► *Dynamical systems and ergodic theory*

1079-37-121 **Pavel Bleher, Mikhail Lyubich and Roland Roeder*** (rroeder@math.iupui.edu). *Expanding Blaschke Products for the Lee-Yang zeros on the Diamond Hierarchical Lattice.*

In a classical work, Lee and Yang proved that zeros of certain polynomials (partition functions of Ising models) always lie on the unit circle. Distribution of these zeros control phase transitions in the model. We study this distribution for a special “Migdal-Kadanoff hierarchical lattice”. In this case, it can be described in terms of the dynamics of an explicit rational function in two variables. More specifically, we prove that the renormalization operator is partially hyperbolic and has a unique central foliation. The limiting distribution of Lee-Yang zeros is described by a holonomy invariant measure on this foliation. These results follow from a general principal of expressing the Lee-Yang zeros for a hierarchical lattice in terms of expanding Blaschke products allowing for generalization to many other hierarchical lattices. (Received January 03, 2012)

1079-37-243 **Zhenwei Cao** and **Alexander Elgart*** (aelgart@vt.edu), McBryde Hall, Department of Mathematics, Virginia Tech, Blacksburg, VA 24061. *On the efficiency of Hamiltonian-based quantum computation for low-rank matrices.*

Quantum computing is believed to possess more computational power than classical computing on certain computational tasks. Farhi and his collaborators had proposed the adiabatic quantum computing (AQC) as a constructive model for implementing a quantum computer. It was later realized that from a computational complexity point of view AQC is equivalent to all other models for universal quantum computation

We will present an extension of AQC algorithm for the unstructured search to the case when the number of marked items is unknown but is relatively small. The algorithm maintains the optimal Grover speedup and includes a small counting subroutine.

Our results include in particular upper and lower bounds on the amount of time needed to perform a general Hamiltonian-based quantum search, a lower bound on the evolution time needed to perform a search that is valid in the presence of control error and a generic upper bound on the minimum eigenvalue gap for evolutions. (Received January 16, 2012)

1079-37-273 **Xiaoying Han***, xzh0003@auburn.edu. *Random Attractors for Stochastic Lattice Differential Equations in Weighted Spaces.*

In this talk we present the asymptotic behavior of solutions to the first and second order stochastic lattice differential equation with multiplicative/additive white noise in weighted space. We first provide some sufficient conditions for the existence and uniqueness of solutions, and then establish the existence of tempered random bounded absorbing sets and global random attractors. (Received January 16, 2012)

1079-37-329 **Gangaram S. Ladde*** (gladde@usf.edu), Department of Mathematics and Statistics, University of South Florida, 4202 East Fowler Avenue, PHY 114, Tampa, FL 33620-5700. *Stochastic Partial Differential Equations: Modeling, Methods and Analysis.* Preliminary report.

Developing a general conceptual algorithm for finding solution process of stochastic partial differential equations, several types of problems are solved in explicit/implicit form. The developed algorithms generate the classical eigenvalue problems. A few examples are given to illustrate scope of the approach. (Received January 17, 2012)

1079-37-357 **Gregory Toole*** (gtoole@math.fsu.edu) and **Monica K. Hurdal**. *Linear Stability Analysis of a Turing Reaction-Diffusion System on an Exponentially Growing Prolate Spheroidal Domain.*

Turing reaction-diffusion systems of two partial differential equations have been used to generate patterns for the mathematical study of many biological and chemical phenomena. Such systems have been predominantly studied on static domains, but growing domain Turing systems have become an increasingly popular tool for pattern generation. Linear stability analysis is a key component of analysis of any Turing system, allowing one to generate mathematical conditions (often called “Turing conditions”) that ensure the system will exhibit Turing pattern generation. We will employ linear stability analysis to obtain Turing conditions for a reaction-diffusion system on an exponentially growing prolate spheroidal domain. (Received January 17, 2012)

1079-37-434 **Emma Previato*** (ep@bu.edu), Department of Mathematics and Statistics, Boston University, Boston, MA 02215-2411. *Sigma-function solutions of the Toda lattice.*

Klein generalized Weierstrass’ σ to higher-genus curves; his construction was recently extended by V.M. Buchstaber, V.Z. Enolskii and D. Leykin. The resulting σ -function is associated to the Riemann theta function ϑ with the Riemann vector of characteristics, and has the advantage of being invariant under the modular group and expandable in weighted (by Weierstrass gaps) abelian variables which correspond to hyperosculating directions to the curve embedded in the Jacobian. These expansions allow us to prove addition formulas, which we use on a hyperelliptic curve to derive the Toda hierarchy. This gives us an algebraic version of the periodicity condition, as well as a dictionary between the Toda lattice and the (generalized) Poncelet theorem of projective geometry (namely, the billiard in an ellipsoid). This is joint work with Y. Kodama and S. Matsutani. (Received January 18, 2012)

39 ► *Difference and functional equations*

1079-39-138 **Evans M Harrell*** (harrell@math.gatech.edu), School of Mathematics, Atlanta, GA 30332-0160, and **Manwah Lilian Wong**, School of Mathematics, Atlanta, GA 30332-0160. *Semiclassical estimates of Green functions and solutions to discrete Schrödinger eigenvalue problems.*

We analyze the asymptotic behavior of solutions to discrete one-dimensional time-independent Schrödinger equations from both standard and nonstandard points of view. Three techniques are used: Perturbation analysis on an appropriate Banach space; a novel approximation in the discrete case in the spirit of the Liouville-Green (WKB) approximation; and analysis of nonlinear equations and identities involving the diagonal part of the Green function. In particular, the diagonal part of the Green function can be used both to construct solutions and an Agmon metric in terms of which growth and decrease of solutions can be studied.

This work is in collaboration with M. Lilian Wong, cf. <http://arxiv.org/abs/1109.4691v1> (Received January 07, 2012)

1079-39-206 **Jun-ichi Inoguchi** (inoguchi@sci.kj.yamagata-u.ac.jp), Department of Mathematical Sciences, Yamagata University, 1-4-12 Kojirakawa-machi, Yamagata, Yamagata 990-8560, Japan, **Kenji Kajiwara*** (kaji@imi.kyushu-u.ac.jp), Institute of Mathematics for Industry, Kyushu University, 744 Motooka, Nishi-ku, Fukuoka, Fukuoka 819-0395, Japan, **Nozomu Matsuura** (nozomu@fukuoka-u.ac.jp), Department of Applied Mathematics, Fukuoka University, Nanakuma, Fukuoka, Fukuoka 814-0180, Japan, and **Yasuhiro Ohta** (ohta@math.sci.kobe-u.ac.jp), Department of Mathematics, Kobe University, Rokko, Kobe, 657-8501, Japan. *Discretization of planar curve motions and discrete modified KdV equations.*

It is well-known that smooth curves on the Euclidean plane admit the motion described by the modified Korteweg-de Vries (mKdV) equation. In this talk we consider the problem of discretization of planar curve motions preserving the underlying integrable structure. More precisely, we introduce the discrete planar curves and discuss their continuous and discrete motions described by the semi-discrete and discrete mKdV equations, respectively. We construct explicit formulas for the curve motions in terms of the tau function. Continuous limit to the motion of smooth curves is also discussed. (Received January 17, 2012)

41 ► *Approximations and expansions*

1079-41-17 **ahmet yildirim*** (ahmetyildirim80@gmail.com), ege university, department of mathematics, 35100 izmir, izmir, Turkey, and **yasir khan, Qingbiao wu and naeem faraz**. *RELIABLE ANALYSIS FOR THE EFFECTS OF VARIABLE VISCOSITY AND THERMAL CONDUCTIVITY ON THE FLOW AND HEAT TRANSFER IN A LAMINAR LIQUID FILM ON A HORIZONTAL SHRINKING/STRETCHING SHEET.*

We analyzed the effects of variable viscosity and thermal conductivity on the flow and heat transfer in a laminar liquid film on a horizontal shrinking/stretching sheet. The similarity transformation reduces the time independent boundary layer equations for momentum and thermal energy into a set of coupled ordinary differential equations. The resulting five-parameter problem is solved by homotopy perturbation method. The results are presented graphically to interpret various physical parameters appearing in the problem. (Received October 16, 2011)

1079-41-174 **canan unlu*** (unlucanan@hotmail.com), istanbul university, science faculty, department of mathematics, 34134 istanbul, istanbul, Turkey, and **ahmet yildirim, syed tauseef mohyud-din and zehra pinar**. *VARIATIONAL ITERATION METHOD FOR SOLVING THE FRACTIONAL-ORDER BURGERS-POISSON EQUATION.* Preliminary report.

In this letter, we obtained the approximate analytical solution of the fractional-order Burgers-Poisson equation with the help of approximate analytical method of nonlinear problem called the Variational Iteration Method (VIM). By using initial condition, the explicit solution of the equation has been derived which demonstrate the effectiveness, validity, potentiality and reliability of the method in reality. (Received January 11, 2012)

1079-41-202 **Rostyslav Kozhan***, UCLA Mathematics Department, Box 951555, Los Angeles, CA 90095, and **Rowan Killip**. *Radial distribution of zeros of random orthogonal polynomials on the unit circle*. Preliminary report.

We obtain the asymptotic radial distribution of zeros of orthogonal polynomials on the unit circle when the random Verblunsky coefficients α_n decay as $O(1/\sqrt{n})$ (Received January 12, 2012)

1079-41-275 **Vasily Prokhorov*** (prokhoro@jaguar1.usouthal.edu), Department of Mathematics and Statistics, ILB 325 University of South Alabama, 307 North University Blvd, Mobile, AL 36688-0002. *On rational approximation on discrete sets of the complex plane*. Preliminary report.

We discuss some questions related to rational approximation of analytic functions on discrete sets of points of the complex plane, including properties of the discrete Hankel operator, an analogue of the AAK theorem, and rational approximation of Markov functions. (Received January 16, 2012)

42 ► Fourier analysis

1079-42-3 **Mauro Maggioni*** (mauro.maggioni@duke.edu), 117 Physics Bldg, BOX 90320, Duke University, Durham, NC 27708. *Digital data sets: Geometry, random walks, multiscale analysis, and applications*.

Large, high-dimensional data sets arise in a wide variety of problems, for example in imaging, computer vision, information extraction from text corpora, design of recommendation systems, analysis of high-dimensional dynamical systems, just to mention a few. While many digital data sets naturally present themselves in the form of high-dimensional vectors, others are in the form of graphs. Notwithstanding the large variability of data types, modalities, tasks, we show that there are overarching mathematical principles, techniques and algorithms that provide insight into the structure of data sets and associated machine learning tasks, and also yield fast numerical algorithms. This general framework uses ideas from the analysis of diffusion processes on graphs, constructions in geometric measure theory, multiscale analysis, high-dimensional probability, as well as numerical analysis. We discuss two incarnations of this framework: the first one leads to a geometric analysis of high-dimensional data sets, associated with a novel fast multiscale geometric transform, efficient dictionary learning algorithms and encodings for high-dimensional data; the second one yields new tools for the analysis of time series of graphs, for example for the detection of anomalies or network attacks. (Received January 16, 2012)

1079-42-14 **Uday Singh*** (usingh2280@yahoo.co.in), Department of Mathematics, Indian Institute of Technology Roorkee, Roorkee, 247667, India. *A Relaxed Estimate of the Degree of Fourier Approximation in Generalized Hölder Metric by Matrix Means*.

Recently, Liendler [A relaxed estimate of the degree of approximation by Fourier series in generalized Hölder Metric, *Analysis Mathematica*, 35(2009), 51-60] has given a relaxed estimate pertaining to the degree of approximation of functions a new Banach space introduced by Das et. al. [An estimate of the rate of convergence of Fourier series in generalized Hölder Metric, *Analysis and Applications* (Ujjain, 1999), Narosa (New Delhi, 2002), 43-60.] through partial sums of Fourier series of as well as Nörlund, Reisz and de la Vallée - Poussin means of Fourier series of . In this paper, we extend the results of Liendler to more general class of triangular matrices such that results of Liendler become particular cases of our result. (Received September 30, 2011)

1079-42-194 **Brian Simanek*** (bsimanek@caltech.edu), 1200 E. California Blvd., MC 253-37, Pasadena, CA 91125. *Ratio Asymptotics for General Orthogonal Polynomials*.

We will discuss some new results concerning ratio asymptotics and relative asymptotics for orthogonal polynomials in settings where a finite term recursion relation for these polynomials does not exist. In particular, we will mention a ratio asymptotic result that holds when the measure of orthogonality is supported on the closed unit disk and we will show that the orthonormal polynomials are stable under certain perturbations of the corresponding measure. (Received January 12, 2012)

1079-42-320 **Uwe Kähler*** (ukaehler@ua.pt), Department of Mathematics, University of Aveiro, 3810-193 Aveiro, Portugal. *Gabor frames in Dirac analysis*.

In recent years there is an increased interest in image processing using hypercomplex signals, useful due to the representation of 2D signals into a quaternion-valued frequency domain. The two main approaches are the hypercomplex signal by Błow and the monogenic signal by Felsberg and Sommer. While there is a lot of work done regarding interpretation of the phase, Hilbert pairs, hypercomplex wavelets, etc. not much is done regarding the discretization of the corresponding Gabor transform. This is mainly due to the lack of the

necessary tools, such as the Zak transform or the Bargmann transform in the corresponding function theories. Here we discuss the construction of such tools, derive several of their properties, and the discretization of a suitable representation for the Gabor kernel. Moreover, we are interested in the critical case, that is to say, the case in which the Gabor system generated by the window is a Riesz basis and, therefore, it yields unique unconditionally convergent expansions where the coefficients stably encode the norm of the signal. Finally, we prove the Balian-Low theorem for the associated Gabor system, a theorem which expresses the fact that time-frequency concentrations are incompatible with non-redundancy for orthonormal Gabor systems. (Received January 17, 2012)

1079-42-362 **Katie Gittins, Norbert Peyerimhoff** and **Mihai Stoiciu*** (mstoiciu@williams.edu), Department of Mathematics and Statistics, Williams College, Williamstown, MA 01267, and **Djoko Wirosoetisno**. *Spectral Applications of McMullen's Hausdorff Dimension Algorithm*. Preliminary report.

We consider singular continuous measures on the unit circle obtained as limit measures of groups generated by reflections in the hyperbolic plane. We extend McMullen's Hausdorff dimension algorithm to approximate the moments of these measures. This allows us to study the corresponding orthogonal polynomials on the unit circle and to investigate various spectral properties of the associated CMV matrices. (Received January 17, 2012)

43 ► *Abstract harmonic analysis*

1079-43-105 **Chal Benson*** (bensof@ecu.edu) and **Gail Ratcliff**. *Well-behaved multiplicity free actions*.

Let K be a compact Lie group acting unitarily on a finite dimensional hermitian vector space V and form the associated representation of K in the polynomial ring $\mathbb{C}[V]$. One calls $K : V$ a (linear) *multiplicity free action* when this associated representation is multiplicity free. We introduce a criterion for such an action to be *well-behaved*. This imposes a compatibility between the moment mapping for $K : V$ and highest weight vectors occurring in $\mathbb{C}[V]$. Our main result is that if $K : V$ is irreducible then it is well-behaved. Our proof involves case-by-case analysis working from Kac's classification of irreducible multiplicity free actions. The study of well-behaved multiplicity free actions is motivated by an application to analysis with spherical functions for Gelfand pairs associated with Heisenberg groups. (Received December 29, 2011)

44 ► *Integral transforms, operational calculus*

1079-44-44 **Raluca Felea*** (rxfsma@rit.edu), Rochester Institute of Technology, Rochester, NY 14620. *An inverse problem in common midpoint SAR imaging*.

We analyze the microlocal properties of the forward operator F which appears in common midpoint Synthetic Aperture Radar imaging and prove that it is a Fourier integral operator with singularities. To reconstruct an image, we study the normal operator F^*F and show that it can be written as a sum of four operators belonging to $IP^{s,l}(\Delta, C_i)$, where C_i are local canonical graphs which represent the artifacts. This is joint work with G. Ambartsoumian, V. Krishnan, C. Nolan and T. Quinto. (Received December 02, 2011)

1079-44-181 **Gaik Ambartsoumian***, gambarts@uta.edu, and **Rim Gouia** and **Venky Krishnan**. *Injectivity and Exact Inversion of Ultrasound Operators in the Spherical Geometry*.

In ultrasound tomography an emitter sends acoustic waves through the body, and the reflections of these waves are registered by a receiver. These data measured for various locations of emitter and receiver are then used to reconstruct the acoustic reflectivity function, which represents an image of the interior of the body. Mathematically this procedure is equivalent to the inversion of an operator, which puts into correspondence to the image function, the measured reflections at available receiver locations. The talk discusses the injectivity of ultrasound operators in the spherical geometry of data acquisition, and exact inversion procedures derived for several setups in this geometry. This is joint work with Rim Gouia and Venky Krishnan. (Received January 11, 2012)

46 ► *Functional analysis*

1079-46-12 **Alexander A. Katz*** (katza@stjohns.edu), St. John's University, St. John's College of LAS, Dep. of Math & CS, 300 Howard Ave., DaSilva AC 314, Staten Island, NY 10301. *On a version of Jordan-Takeda-Grothendieck theorem for locally C^* -algebras.*

A Jordan-Takeda-Grothendieck theorem gives us a dual space characterization of C^* -algebras among Banach $*$ -algebras with continuous involutions as those in which every continuous linear functional is a difference of two positive linear functionals. A first version of a dual characterization of locally C^* -algebras among complete Hermitean lmc^* -algebras was proposed by Bhatt and Karia in 1993. In the present paper we give a following version of a dual characterization of locally C^* -algebras among lmc^* -algebras: THEOREM. A complete lmc^* -algebra is topologically $*$ -isomorphic to a locally C^* -algebra iff every continuous linear functional on it is a finite linear combination of representable linear functionals. (Received September 20, 2011)

1079-46-23 **Sahar Mohamed Ali*** (saharm_ali@yahoo.com), Ain Shams University, Faculty of Science, Department of Mathematics, Cairo, Egypt. *Generalization of the Fixed Point Theorems for Dass-Gupta and Chatterjee type Mappings.*

In this paper we generalize the Chatterjee type Mappings and prove some fixed point theorems for such generalized type mappings.

(Received November 05, 2011)

1079-46-54 **Emmanuel Fricain*** (fricain@math.univ-lyon1.fr), Institut Camille Jordan, 43, boulevard du 11 novembre 1918, 69622 Villeurbanne, France. *Zero-free regions for Dirichlet series.*

In this talk, we are interested in zero-free regions for a large class of Dirichlet series. Using a functional method and the theory of Hardy spaces, we give some explicit zero-free discs and a criterion of Beurling-Nyman's type which improve some recent results of Nikolski and de Roton. This method allows us also to obtain a new criterion for the Siegel zero problem.

It is a joint work with C. Delaunay, E. Mosaki and O. Robert. (Received December 12, 2011)

1079-46-80 **Alexander J. Izzo*** (aizzo@math.bgsu.edu), Department of Mathematics and Statistics, Bowling Green State University, Bowling Green, OH 43403. *Some theorems on function algebras inspired by a problem in operator theory.* Preliminary report.

I will present some function algebra results that were inspired by a problem in operator theory. (Received December 19, 2011)

1079-46-185 **Teck C. Lim*** (tlim@gmu.edu). *Fixed points of Nonexpansive Maps on the Hilbert sphere.* Preliminary report.

Let S be the unit sphere of a Hilbert space H , i.e. $S = \{x \in H : \|x\| = 1\}$. Let the metric on S be the geodesic metric d . If K is a nonempty closed geodesic convex subset of S with geodesic diameter strictly less than $\pi/2$, then every nonexpansive selfmap of K has a fixed point. An example shows that the theorem fails if diameter of K is greater than or equal to $\pi/2$. Our methods also show how fixed points can be approximated. (Received January 12, 2012)

1079-46-208 **Rudi Weikard*** (rudi@math.uab.edu), Department of Mathematics, University of Alabama at Birmingham, Birmingham, AL 35294-1170. *Inverse scattering for a left-definite problem.*

The Camassa-Holm equation is a nonlinear evolution equation describing certain wave phenomena. The Cauchy problem for this PDE can be tackled by solving a scattering and an inverse scattering problem for the linear Sturm-Liouville equation $-y'' + y = \lambda w y$ where λ is a complex parameter and w a function connected to the Camassa-Holm equation.

Particularly interesting, since it is related to wave breaking, is the case where w changes sign. This prevents setting up the problem in $L^2(w)$. Instead one can use the left-hand side of the equation to define a positive-definite inner product forming the basis for a spectral and scattering theory.

This is joint work with Christer Bennewitz (Lund) and Malcolm Brown (Cardiff). (Received January 13, 2012)

47 ► Operator theory

1079-47-11 **Mehdi Nikpour*** (mnikpou@rockets.utoledo.edu), Department of Mathematics and Statistics, The University of Toledo, 2801 W. Bancroft St., Toledo, OH 43606-3390. *On Toeplitzity of Composition Operators.*

Building on techniques developed by Cowen and Nazarov-Shapiro, it is shown that the adjoint of composition operators, induced with unit disc-automorphisms, are not strongly asymptotically Toeplitz, the notion introduced by Barria and Halmos. This result sheds (soft) light on the Nazarov-Shapiro's guess. Also, Toeplitzity of the product of a composition operator with its adjoint are studied. (Received September 17, 2011)

1079-47-19 **Injo Hur*** (ihur@math.ou.edu), The University of Oklahoma, PhSC Room#423 Department of Mathematics, 601 Elm Avenue, Norman, OK 73019, and **Christian Remling**, The University of Oklahoma, PhSC Room#423 Department of Mathematics, 601 Elm Avenue, Norman, OK 73019. *Ergodic Jacobi matrices and conformal maps.*

We study structural properties of the Lyapunov exponent γ and the density of states k for ergodic (or just invariant) Jacobi matrices in a general framework. In this analysis, a central role is played by the function $w = -\gamma + i\pi k$ as a conformal map between certain domains. This idea goes back to Marchenko and Ostrovskii, who used this device in their analysis of the periodic problem. (Received October 19, 2011)

1079-47-65 **Matthew McBride***, 402 N. Blackford St., LD 270, Indianapolis, IN 46202, and **Slawomir Klimek**. *Global boundary conditions for a Dirac operator on the solid torus.*

A Dirac operator subject to Atiyah-Patodi-Singer like boundary conditions on the solid torus is studied and it is shown that the corresponding boundary value problem is elliptic, in the sense that the Dirac operator has a compact parametrix. (Received December 14, 2011)

1079-47-77 **Richard Rochberg*** (rr@math.wustl.edu). *Hankel Forms on Model Spaces.* Preliminary report.

Truncated Toeplitz operators are classical Toeplitz operators compressed to a co-invariant subspace (a "model space"), K , inside the Hardy space, $K = H^2 \ominus \Theta H^2$. I will define Hankel forms on K and will describe how the conjugation operator on K sets up an isometric bijection between the space of Hankel forms and the space of truncated Toeplitz operators. I will also give a brief description of some recent results about these Hankel forms and mention open questions. (Received December 16, 2011)

1079-47-78 **Leiba Rodman** and **Ilya M Spitkovsky***, ilya@math.wm.edu. *Compressions of linearly independent selfadjoint operators.*

The following question is considered: What is the smallest number $\gamma(k)$ with the property that for every family $\{X_1, \dots, X_k\}$ of k selfadjoint and linearly independent operators on a real or complex Hilbert space \mathcal{H} there exists a subspace $\mathcal{H}_0 \subset \mathcal{H}$ of dimension $\gamma(k)$ such that the compressions of X_1, \dots, X_k to \mathcal{H}_0 are still linearly independent?

Upper and lower bounds for $\gamma(k)$ are established for any k , and the exact value is found for $k = 2, 3$. It is also shown that the set of all $\gamma(k)$ -dimensional subspaces \mathcal{H}_0 with the desired property is open and dense in the respective Grassmannian.

The $k = 3$ case is used to prove that the ratio field of values $W(A/B)$ of a pair of operators on a Hilbert space either has a non-empty interior, or lies in a line or a circle. Time permitting, an application to the product field of values will also be presented. (Received December 17, 2011)

1079-47-183 **Tim Raeymaekers*** (tr@cage.ugent.be), Ghent University, Department of Mathematical Analysis, Galglaan 2, 9000 Gent, Belgium, and **David Eelbode** and **Hennie De Schepper**. *Monogenics in k variables.*

Monogenic functions in one vector variable, and in particular homogeneous polynomials, have always played a key role in classical Clifford Analysis; they are defined as null solutions for the Dirac operator and provide models for (finite-dimensional) irreducible representations for the spin group. Monogenic polynomials in two vector variables (double monogenics) can be used to describe the structure of the set of polynomial solutions of the Rarita-Schwinger operator. In this talk we will generalize the notion of monogenic functions to an arbitrary number of variables. Using the notion of transvector algebras, we will then use these special polynomials to describe the structure of the kernel of arbitrary higher spin Dirac operators (generalizations of the Rarita-Schwinger operator). (Received January 12, 2012)

1079-47-201 **Mrinal Raghupathi*** (mrinalraghupathi@gmail.com) and **Ryan Hamilton**. *The Toeplitz corona problem for algebras of multipliers on a Nevanlinna-Pick space.*

Suppose \mathfrak{A} is an algebra of operators on a Hilbert space H and $A_1, \dots, A_n \in \mathfrak{A}$. If the row operator $[A_1, \dots, A_n] \in B(H^{(n)}, H)$ has a right inverse in $B(H, H^{(n)})$, the Toeplitz corona problem for \mathfrak{A} asks if a right inverse can be found with entries in \mathfrak{A} . When H is a complete Nevanlinna-Pick space and \mathfrak{A} is a weakly-closed algebra of multiplication operators on H , we show that under a stronger hypothesis, the corona problem for \mathfrak{A} has a solution. When \mathfrak{A} is the full multiplier algebra of H , the Toeplitz corona theorems of Arveson, Schubert and Ball-Trent-Vinnikov are obtained. A tangential interpolation result for these algebras is developed in order to solve the Toeplitz corona problem. (Received January 12, 2012)

1079-47-221 **Carl C Cowen***, IUPUI Dept of Mathematical Sciences, 402 N Blackford St, Indianapolis, IN 46202-3216. *Some Old Thoughts about Commutants*. Preliminary report.

Except in special circumstances, it is usually quite difficult to determine conditions to characterize which operators commute with a given operator. Such special circumstances include use of the spectral theorem for self-adjoint or normal operators and cases in which the operator in question has a rich point spectrum. The results in this latter situation come from the application of the fairly trivial observation that if $Av = \lambda v$ and A and B commute, then $A(Bv) = \lambda(Bv)$ so that the eigenspaces of A are invariant for B . Often operators connected with spaces of analytic functions have enough eigenspaces to provide interesting results about the commutants of such operators.

This talk will be a reiteration of some of the old ideas related to this topic and a reflection on current and future applications of these ideas. (Received January 14, 2012)

1079-47-260 **Katie Spurrier Quertermous*** (querteks@jmu.edu), Department of Mathematics and Statistics, MSC 1911, James Madison University, Harrisonburg, VA 22807. *Fixed Point Composition and Toeplitz-Composition C^* -algebras*.

Let φ be an analytic self-map of the unit disk \mathbb{D} , and let $H^2(\mathbb{D})$ denote the Hardy space of the disk. We define the composition operator C_φ by $C_\varphi f = f \circ \varphi$ for all $f \in H^2(\mathbb{D})$. We are particularly interested in composition operators induced by linear-fractional, non-automorphism self-maps of \mathbb{D} that fix a given point ζ on the unit circle and satisfy $\varphi'(\zeta) \neq 1$.

In this talk, we consider C^* -algebras generated by a composition operator of this form and either the unilateral shift T_z or the ideal \mathcal{K} of compact operators. We identify the structures of these C^* -algebras, modulo the ideal of compact operators, and calculate the essential spectra of a class of algebraic combinations of composition operators. By combining our results with the work of Jury and Kriete, MacCluer, and Moorhouse, we obtain a full description of the structures of the C^* -algebras $C^*(T_z, C_\varphi)/\mathcal{K}$, where φ is any linear-fractional self-map of \mathbb{D} . (Received January 16, 2012)

1079-47-307 **Keshav R Acharya*** (kacharya@math.ou.edu), Department of Mathematics, University of Oklahoma, Norman, OK 73019. *Spectral Theory of a Canonical System*.

The aim of this paper is to show that, in the limit circle case, the deficiency index of a Symmetric relation induced by a Canonical System $Ju' = zHu$ where $J = \begin{pmatrix} 0 & -1 \\ 1 & 0 \end{pmatrix}$ and $H(x)$ is a positive semidefinite, 2×2 -matrix whose entries are locally integrable functions, is constant for all complex numbers z . This provides a simple proof of the limit point case for the Canonical System when $\text{trace} H \equiv 1$. To this end, we first discuss the deficiency indices and spectral theory of any symmetric relation in a Hilbert space \mathcal{H} . Then we analyze the spectrum of the relation induced by a Canonical System. (Received January 17, 2012)

1079-47-308 **Fritz Gesztesy, Yuri Latushkin and Konstantin A. Makarov*** (makarovk@missouri.edu), Department of Mathematics, University of Missouri, Columbia, MO 65211, and **Fedor Sukochev and Yuri Tomilov**. *The index formula and the spectral shift function for relatively trace class perturbations*.

Let $\mathbb{R} \ni t \mapsto A_t$ be a path of self-adjoint operators in a separable Hilbert space H such that the limits $A_\pm = \lim_{t \rightarrow \pm\infty} A_t$ exist. In the case when A_t is a relative trace class perturbation of A_- , we derive an extension of Pushnitski's formula:

$$\xi(\lambda; DD^*, D^*D) = \frac{1}{\pi} \int_{-\sqrt{\lambda}}^{\sqrt{\lambda}} \frac{\xi(\nu; A_+, A_-)}{\sqrt{\lambda - \nu^2}} d\nu, \quad \text{for a. e. } \lambda > 0,$$

where $\xi(A, B)$ denotes the spectral shift function associated with the pair of self-adjoint operators (A, B) and the operator D in $L^2(\mathbb{R}, H)$, associated with the path A_t , is given by

$$D = \frac{d}{dt} + A_t.$$

This formula is used to identify the Fredholm index of D with $\xi(0; A_+, A_-)$. (Received January 17, 2012)

1079-47-345 **Roger Nichols***, Mathematics Department, 202 Mathematical Sciences Bldg, University of Missouri, Columbia, MO 65211, and **Fritz Gesztesy**. *On the Infinite Volume Limit of Spectral Shift Functions*.

Using methods based on convergence of Fredholm determinants, we derive results of the type

$$\lim_{R \rightarrow \infty} \int_{\mathbb{R}} \xi(\lambda; H_R, H_{0,R}) f(\lambda) d\lambda = \int_{\mathbb{R}} \xi(\lambda; H, H_0) f(\lambda) d\lambda,$$

where $\xi(\cdot; A, B)$ denotes the spectral shift function associated with the pair of self-adjoint operators A and B . Here $H_R, H_{0,R}$ is an appropriate pair of self-adjoint operators associated with a finite volume, Λ_R , with H, H_0 the corresponding pair of self-adjoint operators in the infinite volume limit $R \rightarrow \infty$ and $f \in C_\infty(\mathbb{R})$, the continuous functions vanishing at $\pm\infty$. In a one-dimensional context, $\Lambda_R = [0, R]$, $R > 0$, these results apply to Schrödinger operators with any separated boundary conditions at 0 and R . These results are also applicable to n -dimensional Schrödinger operators and also to abstract scattering theoretic situations. (Received January 17, 2012)

1079-47-408 **David Damanik** (damanik@rice.edu), **Paul E. Munger*** (pem1@rice.edu) and **William Yessen** (wyessen@uci.edu). *Orthogonal Polynomials on the Unit Circle with Fibonacci Verblunsky Coefficients*.

We study probability measures on the unit circle corresponding to orthogonal polynomials whose sequence of Verblunsky coefficients is invariant under the Fibonacci substitution. We focus in particular on the fractal properties of the essential support of these measures. (Received January 18, 2012)

1079-47-412 **Evgeny Abakumov** and **Constanze Liaw***, Department of Mathematics, Texas A&M University, Mailstop 3368, College Station, TX 77843, and **Alexei Poltoratski**. *Finding cyclic vectors*.

In perturbation theory, the cyclicity of an operator is often a natural assumption in the hypothesis of many results. So far, the problem of finding a cyclic vector has attracted only little attention. We will discuss two results in that direction, as well as their striking applications:

In the first part, we will learn how to find many cyclic vectors for rank one perturbations, and consider some applications concerning the locations where functions of the Payley–Wiener class are allowed to have zeros.

Then we will turn our attention to so-called Anderson-type Hamiltonians (a generalization of random Schroedinger operators) and state that under mild conditions, every non-zero vector is cyclic almost surely. (Received January 18, 2012)

49 ► *Calculus of variations and optimal control; optimization*

1079-49-239 **Hyeng Keun Koo*** (hkoo@ajou.ac.kr), San 5 Wonchun-dong Yeongtong-gu, Suwon, Kyunggi 443-749, South Korea, and **Shanjian Tang**, **Gyoocheol Shim** and **Yong Hyun Shin**. *A Dynkin game with a Recursive Objective Function given by a Backward Stochastic Differential Equation and Its Associated Nonlinear Backward Stochastic Partial Differential Inequality*. Preliminary report.

We study a Dynkin game for stochastic differential equations with random coefficients, but under a recursive objective function, which is a natural extension of Tang and Yang's recent work. The objective function is specified by a BSDE, which can accommodate the stochastic differential utility and/or ambiguity aversion, frequently arising in the models of financial economics. We prove the verification theorem that the Nash equilibrium point and the value of the game is characterized by the strong solution of the associated Hamilton-Jacobi-Bellman-Isaacs equation, which takes the form of a backward stochastic partial differential variational inequality. We provide results concerning existence and uniqueness for the strong solution of the BSPDVI. (Received January 15, 2012)

51 ► Geometry

1079-51-58 **Boris Okun*** (okun@uwm.edu) and **Richard Scott**. *The Strong Atiyah Conjecture for the weighted L^2 -Betti numbers of the infinite dihedral group.*

The Strong Atiyah Conjecture predicts possible denominators for the L^2 -Betti numbers of a space with a proper cocompact group action in terms of the torsion of the group. For reflection type actions by Coxeter groups there is a deformation of the usual L^2 -theory, the so-called weighted L^2 -homology. I will explain what seems to be an appropriate generalization of the Strong Atiyah Conjecture in the weighted setting, and give its proof in the simplest nontrivial case — the infinite dihedral group. This a joint work with Richard Scott (Santa Clara University). (Received December 13, 2011)

1079-51-61 **Jerzy Dydak** and **Atish Mitra*** (atish.mitra@gmail.com), St Petersburg, FL 33701. *Large Scale Absolute Extensors.*

For any metric space we define the concept of large scale absolute extensors of that space and study their properties. We give several characterizations of large scale absolute extensors and relate this concept with other approaches to asymptotic extensors. We relate this new concept to asymptotic dimension of M.Gromov and discuss some applications. (Received December 13, 2011)

1079-51-87 **Egon Schulte*** (schulte@neu.edu), Northeastern University, Department of Mathematics, Boston, MA 02115. *Polyhedral Complexes for Crystallographic Groups.* Preliminary report.

Highly symmetric discrete structures in euclidean 3-space have a long and fascinating history. Various notions of polyhedral structures have attracted attention and have brought to light new exciting figures intimately related to finite or infinite groups of isometries.

A “skeletal” approach pioneered by Grunbaum in the mid 1970’s views polyhedra as finite or infinite periodic graphs equipped with additional face structure. Since then, there has been a lot of activity in this area, beginning with the full enumeration of the “new” regular polyhedra by Grunbaum and Dress around 1980, moving to the full enumeration of chiral polyhedra around 2005, and recently continuing with the enumeration of the finite regular polyhedra in 4-space by McMullen.

While these structures have the essential characteristics of polyhedra and polytopes, the more general class of discrete “polygonal complexes” is a hybrid of polytopes and incidence geometries. In very recent joint work with Daniel Pellicer, a complete classification of the regular polygonal complexes was obtained. These are periodic structures with crystallographic symmetry groups exhibiting interesting geometric, combinatorial, and algebraic properties. We give a brief overview of the classification. (Received December 20, 2011)

1079-51-203 **Hongchan Zheng*** (zhenghc@nwpu.edu.cn), No 127 Youyi West Road, Xian, Shaanxi 710072, Peoples Rep of China, and **Juan Wang** and **Dekong Liu**. *THE CONVERGENT AND FRACTAL PROPERTIES OF KOCH SUBDIVISION SCHEME.*

In this paper, firstly we propose a nonlinear interpolatory subdivision scheme with one parameter based on normal vector called Koch subdivision scheme. The classical Koch curves and other Koch-type curves can be generated directly and quickly by applying this subdivision scheme. It can be generalized to a nonlinear interpolatory subdivision scheme with three parameters which can be used to generate a class of more generalized Koch-type curves. Secondly, we analyze the convergent property of Koch subdivision scheme. Finally, we analyze its fractal properties including the property of non-rectifiability and that of continuity but nowhere differentiability. The results show that when the parameter is selected properly the limit curves of Koch subdivision scheme can really be fractals. (Received January 12, 2012)

1079-51-294 **Sukanya Basu*** (basus@gvsu.edu), Grand Valley State University, A-2-136 Mackinac Hall, 1 Campus Drive, Allendale, MI 49401-6495. *On the Connection between a Class of Discrete Dynamical Systems and Some Plane Algebraic Curves.*

We will analyze the global behavior of solutions to a class of nonlinear discrete dynamical systems with applications in the natural sciences. In particular, we will show that the global dynamics of these solutions are determined by certain plane algebraic curves. (Received January 17, 2012)

1079-51-323 **Thomas F. Banchoff*** (Thomas_Banchoff@brown.edu), Mathematics Department, Brown University, Providence, RI 02912. *Inflection Triangles and Mean Curvature Zeros in Strips and the Elementary Geometry of Normal Characteristic Classes.* Preliminary report.

A “strip” of planar triangles consists of a sequence of triangles joined along edges in three-dimensional space, with the last triangle joined to the first and with no two adjacent triangles coplanar. An “inflection face” of a strip is a triangle such that the two adjacent triangles lie on different sides of the plane containing the triangle.

Theorem A: A strip is a topological cylinder or a Moebius band depending on whether the number of inflection faces is even or odd. A related result is Theorem B: For a simple closed curve on a generically immersed surface without boundary, a normal neighborhood of the curve is a topological cylinder or a Moebius strip depending on whether the curve has an even or an odd number of points where the mean curvature vector HN is zero. These observations are illustrations of the elementary geometry of normal characteristic classes, connected with properties of the integer normal Euler class of a smooth or (possibly locally knotted) polyhedral immersion of a closed surface in four-space. (Received January 17, 2012)

1079-51-371 **Thomas Bieske*** (tbieske@mail.usf.edu), Department of Mathematics and Statistics, University of South Florida, 4202 E Fowler Ave, PHY114, Tampa, FL 33620-5700, and **Jasun Gong** (jasun.gong@aalto.fi), Aalto University (TKK), Institute of Mathematics, P.O. Box 11100, 00076 Aalto Espoo, Finland. *Problems in Metric-Space Analysis*.

This will be a forum for open problems in the Analysis on Metric Spaces and other related topics, with the aim of fostering future research collaborations.

Participants of the Special Session, whether graduate student or distinguished professor, are encouraged to suggest a problem. We only ask that each problem be explained in 4 minutes or less, with a possible (brief) discussion with the audience before the next problem is posed. (Received January 18, 2012)

1079-51-390 **Thomas Dickerson*** (tdickerson@mail.smcvt.edu), **Greta Pangborn** and **Greg McCole**. *Computational Generation of Crystal Nets*.

We outline an algorithm that can, in principle, enumerate all crystal nets (up to isomorphism) in geometric realizations of maximal symmetry, and we look at the version of the program currently under development. The program itself consists largely of matrix manipulations, but it relies on geometric group theory as applied to crystallographic point groups. We consider major problems with crystal net enumeration programs (e.g. the fact that isomorphism does not imply isotopy, the problem of optimizing geometric realizations with respect to physical conditions, the problem of the size of the search spaces involved), and describe how they might be addressed in this and subsequent versions. (Received January 18, 2012)

1079-51-396 **Chaim Goodman-Strauss*** (strauss@uark.edu), SCEN 301, University of Arkansas, Fayetteville, AR 72701. *Recent Crystallographic Sculpture*.

We illustrate Conway's recent classification of the "Prime" crystallographic spacegroups through several recent sculptures. (Received January 18, 2012)

52 ► *Convex and discrete geometry*

1079-52-71 **Bernd Sing*** (bernd.sing@cavehill.uwi.edu), University of the West Indies, Department of CS, Mathematics & Phys., Cave Hill, P.O. Box 64, Bridgetown, BB11000, Barbados, and **Dirk Frettlöh**, Discrete Geometry Group, Institut für Mathematik, Freie Universität Berlin, 14195 Berlin, Germany. *A fundamental domain with D_{12} -symmetry for the hexagonal lattice*. Preliminary report.

The hexagonal lattice is commonly also known as 'honeycomb structure', especially when it is represented using a regular hexagon as its fundamental domain. Obviously, the symmetry group of the regular hexagon is the dihedral group D_6 , however, we present a fundamental domain for the hexagonal lattice that has symmetry group D_{12} (and thus a higher symmetry than the point group of the hexagonal lattice).

A complication with this 12-fold symmetric fundamental domain arises since it is a compact set obtained through an iterated function system that possesses a fractal boundary, i.e., the boundary has Hausdorff dimension greater than 1. Consequently, proving that it is indeed a fundamental domain gets quite involved: We actually show that the set in question arises as *window* in a (four-dimensional) *cut-and-project scheme* that produces a (non-periodic) square-triangle tiling of the plane (see http://tilings.math.uni-bielefeld.de/substitution-rules/square_triangle for a picture of this tiling); from this construction we are then able to infer that it is, in fact, a fundamental domain of the hexagonal lattice. (Received December 16, 2011)

1079-52-228 **Ghulam Mustafa*** (ghulam.mustafa@iub.edu.pk), 2.06 Keenan House, Old Dryburn Way, DH1 5BN, Durham, UK. *Class of non-stationary binary subdivision schemes*. Preliminary report.

Non-stationary subdivision schemes have proven to be efficient iterative algorithms to construct special classes of curves and surfaces. One of the important capabilities of non-stationary schemes is the reproduction or generation of trigonometric polynomials, trigonometric splines and, in particular, circles, ellipses and so on.

Such schemes are useful in computer graphics and geometric modelling. In this paper, we have established the Lagrange identities that are used to construct new families of univariate, binary, non-stationary subdivision schemes with higher smoothness. Other aim of this work is to generate an approximating subdivision scheme with a tension parameter, which is capable of reproducing circles and all other conic sections exactly whenever such a parameter has been chosen correctly. It is observed that the limit curve of the proposed approximating scheme is closer to the initial control polygon and for a certain range of parameter limit curve passes through the initial polygon. Moreover, the proposed schemes are non-stationary counterpart of the some of the existing stationary schemes. The advantages of the schemes are illustrated with examples. (Received January 15, 2012)

1079-52-264 **Benjamin Nill*** (benjamin.nill@case.edu), Department of Mathematics, Yost Hall, 10900 Euclid Avenue, Cleveland, OH 44106, and **Arnau Padrol**, Departament Matemàtica Aplicada II, Edifici Omega, despatx 411, Campus Nord, 08034 Barcelona, Spain. *A combinatorial generalization of the degree of lattice polytopes*. Preliminary report.

The degree of a lattice polytope is an invariant originated in Ehrhart theory. It is a useful measure of complexity for lattice polytopes without interior lattice points. As will be explained in the talk, there is a natural generalization of this notion for combinatorial types of polytopes. Here, this invariant measures "almost-neighborliness". Most of the existing results for lattice polytopes should have analogues in this purely combinatorial setting. We will describe preliminary results and conjectures we are currently working on.

This talk reports on work in progress with Arnau Padrol. (Received January 16, 2012)

1079-52-315 **Jennifer E Padilla*** (jenpadilla@gmail.com), Department of Chemistry, New York University, New York, NY 10003. *Programming Recursive Molecular Self Assembly*.

Tile assembly provides a framework in which to consider physical assembly processes as computations and physical structures as computable objects. Given simple rules for the attachment of tiles, one can easily simulate a Turing machine in the Tile Assembly Model making tile assembly capable of universal computation. However, rather than using the tiles to encode data, shapes and patterns of tiles may be considered to be the output of a tile computation. Substitution tilings such as the Robinson tilings, the Penrose tilings, and many others are produced by a recursive algorithm, and may be assembled hierarchically if one makes certain modifications to the Tile Assembly Model. I will present an example of how one might program tiles to self assemble hierarchically according to substitution rules, and further, how such a scheme may plausibly be embodied using DNA origami tiles. (Received January 17, 2012)

1079-52-356 **Joy Marie D'Andrea*** (jdandrea@mail.usf.edu), 4202 E. Fowler Ave, Tampa, FL 33620. *Transversals of Crystal Nets*.

In crystallography, a crystal net is a three-dimensional Euclidean graph whose vertices or nodes are points in three-dimensional Euclidean space, and whose edges (or bonds or spacers) are line segments connecting pairs of vertices. For example, the program (Gavrog) Systre is often used to study crystal nets and show the results of how many different vertices (atoms) and edges there may be in the net. The number of different vertices and edges are also known as 'orbits'. Given the number of orbits of vertices and edges of a crystal net, one can obtain a 'connected fundamental transversal' of a crystal net. A *connected fundamental transversal* of a crystal net intersects each orbit of vertices and edges exactly once. In following the construction demonstrated by Warren Dicks and M.J Dunwoody, we will present a formal description of a connected fundamental transversal of a crystal net and provide various examples. (Received January 17, 2012)

53 ► *Differential geometry*

1079-53-86 **Chanyoung Jun*** (cyjun2@gmail.com), 1409 W. Green Street, Urbana, IL 61801. *Pursuit-evasion and time-dependent gradient flow in singular spaces*.

Pursuit-evasion games are generated from robotics, control theory and computer simulations. CAT(0) and CAT(K) spaces are suitable playing fields, and vastly generalize the usual playing fields in the pursuit-evasion literature. On these spaces, we prove existence and uniqueness theorems for pursuit curves, as well as convergence estimates and a regularity theorem. Recently, time-independent gradient flow has been studied extensively in CAT(0) spaces. Pursuit curves are downward gradient curves for the distance from a moving evader, that is, for a time-dependent gradient flow. We extend our results to more general time-dependent gradient flow in CAT(0) spaces. (Received December 20, 2011)

1079-53-141 **Kristen Hendricks*** (hendricks@math.columbia.edu). *Smith Inequalities for Knot Floer Homology of Branched Double Covers*.

In 1938, P. Smith proved that, given a space M with an involution τ , the total rank of the singular cohomology of M is greater than or equal to the total rank of the singular cohomology of the invariant set M^{inv} . We discuss an analogous rank inequality for Heegaard Floer knot homology (an invariant of a knot K in a three-manifold Y). To wit, given a knot K in S^3 and of the lift of K in the branched double cover $\Sigma(K)$ of S^3 over K , we explain how a natural involution on the symmetric product of a Heegaard surface for $(\Sigma(K), K)$, together with recent work of Seidel and Smith, can be used to show the rank of the knot Floer homology of $(\Sigma(K), K)$ is greater than or equal to the rank of the knot Floer homology of (S^3, K) . (Received January 08, 2012)

1079-53-209 **Andrew Fano*** (afano@math.columbia.edu). *Toric Structures on Symplectic Bundles of Projective Spaces*. Preliminary report.

Recently, extending work by Karshon, Kessler and Pinsonnault, Borisov and McDuff showed that a given symplectic manifold (M, ω) has a finite number of distinct toric structures. Moreover, McDuff also showed that a product of two projective spaces $\mathbb{C}P^r \times \mathbb{C}P^s$ with any given symplectic form has a unique toric structure provided that $r, s \geq 2$. In contrast, the product $\mathbb{C}P^r \times \mathbb{C}P^1$ can be given infinitely many distinct toric structures, though only a finite number of these are compatible with each given symplectic form ω . In this presentation we extend these results by considering the possible toric structures on a toric symplectic manifold (M, ω) with $\dim H^2(M) = 2$. In particular, all such manifolds are $\mathbb{C}P^r$ bundles over $\mathbb{C}P^s$ for some r, s . We show that there is a unique toric structure if $r < s$, and also that if $r, s \geq 2$ then M has at most finitely many distinct toric structures that are compatible with any symplectic structure on M . Thus, in this case the finiteness result does not depend on fixing the symplectic structure. We will also give other examples where (M, ω) has a unique toric structure, such as the case where (M, ω) is monotone. (Received January 17, 2012)

54 ► General topology

1079-54-40 **Ellie A Grano*** (ellie@math.ucsb.edu), 789 Laurel Walk, Apt. F, Goleta, CA 93117. *The Disambiguated Temperley-Lieb Algebra*. Preliminary report.

The Disambiguated Temperley-Lieb Algebra is a new associative algebra defined using pictures and local relations. I will present my basis for this algebra as a vector space. (Received November 29, 2011)

1079-54-236 **Matthew Graham*** (mdgraham@brandeis.edu), Brandeis University, 415 South St, Mathematics Department, Waltham, MA 02454. *Grid Movie Moves and Combinatorial Knot Floer Homology*. Preliminary report.

Recently, Sarkar showed that a smooth marked cobordism between two knots K_1, K_2 induces a map between the knot Floer homology groups of the two knots $\text{HFK}(K_1), \text{HFK}(K_2)$. It has been conjectured that this map is well defined (with respect to smooth marked cobordisms). After outlining what needs to be shown to prove this conjecture, I will present my current progress towards showing this result for the combinatorial version of HFK. Specifically, I will present a generalization of Carter and Saito's movie move theorem to grid diagrams, give a very brief introduction to combinatorial knot Floer homology and then present a couple of the required chain homotopies needed for the proof of the conjecture. (Received January 15, 2012)

55 ► Algebraic topology

1079-55-30 **Alexander Dranishnikov** and **Thanos Gentimis*** (thanos@uf1.edu), LITTLE HALL 439, Department of Mathematics, University Of Florida, Gainesville, FL 32601. *On cohomology of the Higson compactification of hyperbolic spaces*.

We show that in dimensions > 1 the cohomology groups of the Higson compactification of the hyperbolic space \mathbb{H}^n with respect to the C_0 coarse structure are trivial. Also we prove that the cohomology groups of the Higson compactification of \mathbb{H}^n for the bounded coarse structure are trivial in all even dimensions. (Received November 19, 2011)

1079-55-271 **Maciej Niebrzydowski*** (mniebrz@gmail.com) and **Jozef H. Przytycki**. *Tutte magmas*. Preliminary report.

By a Tutte magma we understand a magma $\mathcal{A} = (A, *)$ that satisfies entropic relations $(x * y) * (z * w) = (x * z) * (y * w)$ for some of its elements x, y, z, w . Using certain Tutte magmas that additionally satisfy relations derived from the second Reidemeister move, we obtain invariants of links. Motivated by a bijection between

signed plane graphs and link diagrams, we define Tutte magma invariants for signed graphs for any magma $(M, *)$ with ordered generators $a_1, a_2, \dots, a_n, \dots$ (not necessarily different). (Received January 16, 2012)

1079-55-324 **Benjamin J Cooper*** (bjc4n@virginia.edu), Kerchof Hall, 224. Cabell Drive, Charlottesville, Charlottesville, VA 22903. *Generalized Hecke Algebras with Applications to Knot Theory*. Preliminary report.

(Work in preparation). Hecke algebras have been closely tied to invariants of knots and links since the foundational work of Jones. I will describe new, geometrically defined, families of these algebras and explain how they can be used to enrich the story surrounding quantum invariants. (Received January 17, 2012)

57 ► *Manifolds and cell complexes*

1079-57-27 **Kashyap Rajeevsarathy*** (kashyap@iiserbhopal.ac.in), IISER Bhopal, ITI (Gas Rahat) Building, Govindapura, Bhopal, MP 462023, India. *Bounds of on the degrees of roots of Dehn twists*.

Let F be a closed orientable surface of genus $g \geq 2$ and C be a simple closed curve in F . Let t_C denote a left handed Dehn twist about C . When C is a nonseparating curve, D. Margalit and S. Schleimer showed the existence of such roots by finding elegant examples of roots of t_C whose degree is $2g + 1$ on a surface of genus $g + 1$. This motivated an earlier collaborative work with D. McCullough in which we derived conditions for the existence of a root of degree n . We also showed that Margalit-Schleimer roots achieve the maximum value of n among all the roots for a given genus. Suppose that C is a separating curve in F . First, we derive algebraic conditions for the existence of roots in $\text{Mod}(F)$ of the Dehn twist t_C about C . Finally, we show that if n is the degree of a root, then $n \leq 4g^2 + 2g$, and for $g \geq 10$, $n \leq \frac{16}{5}g^2 + 12g + \frac{45}{4}$. (Received November 15, 2011)

1079-57-36 **Erica Flapan*** (eflapan@pomona.edu), Department of Mathematics, Pomona College, Claremont, CA 91711. *Topological Symmetry Groups of Molecular Graphs*.

Chemists have defined the *point group* of a molecule as the group of rigid symmetries of its molecular graph in \mathbb{R}^3 . While this group is useful for analyzing the symmetries of rigid molecules, it does not include all of the symmetries of molecules which are flexible or can rotate around one or more bonds. To study the symmetries of such molecules, we define the *topological symmetry group* of a graph embedded in \mathbb{R}^3 to be the subgroup of the automorphism group of the abstract graph that is induced by homeomorphisms of \mathbb{R}^3 . This group gives us a way to understand not only the symmetries of non-rigid molecular graphs, but the symmetries of any graph embedded in \mathbb{R}^3 . In this talk we will present a survey of results about topological symmetry groups and how they can play a role in analyzing the symmetries of non-rigid molecules. (Received November 27, 2011)

1079-57-48 **Matt Sequin*** (sequin.2@osu.edu). *Comparing Quantum 3-Manifold Invariants: The Hennings Invariant and the Kuperberg Invariant*.

We will compare two different quantum 3-manifold invariants, both of which are given using a finite dimensional Hopf Algebra H . One is the Hennings invariant, given by an algorithm involving the link surgery presentation of a 3-manifold and the Drinfeld double $D(H)$; the other is the Kuperberg invariant, which is computed using a Heegaard diagram of the 3-manifold and the same H . We have shown that when H has the property of being involutory, these two invariants are actually equivalent. The proof is totally algebraic and does not rely on general results involving categorical invariants. Finally, we will discuss some progress in generalizing this proof to the case where H is not involutory. (Received December 08, 2011)

1079-57-99 **Davide M Proserpio*** (davide.proserpio@unimi.it), via venezian 21, Milano, 20133, and **Vladislav A Blatov** (blatov@ssu.samara.ru), Ac. Pavlov St. 1, Samara. *Topological Crystal Chemistry : nets and entanglements in periodic structures*.

In the rationalization process of the complex structures called coordination networks / Metal-Organic Frameworks (MOF) it is very helpful the "topological approach" that consists in the simplification by rational principles of the complex structures to schematized reference nets. A higher level of complexity comes from the interpenetration and entanglement of different periodic motifs whose rationalization and classification we have illustrated in the last years. We think that the understanding of the topology and the entanglement phenomena in this kind of materials could be a powerful tool to disclose the relationships between structure and function. We will address the most recent results and leave some open questions. See: "TOPOLOGICAL CRYSTAL CHEMISTRY: Polycatenation weaves a 3D web" D. M. Proserpio, Nature Chemistry (2010), 2(6), 435-436. "Underlying nets in three-periodic coordination polymers: topology, taxonomy and prediction from a computer-aided analysis of

the Cambridge Structural Database” E. V. Alexandrov, V. A. Blatov, A. V. Kochetkov and D. M. Proserpio, *CrystEngComm*, 2011, 13, 3947-3958 (Received December 27, 2011)

1079-57-152 **Keiko Kawamuro*** (kawamuro@iowa.uiowa.edu), 14 MacLean Hall, Iowa City, IA 52242, and **Tetsuya Ito**. *Essential open book foliation*.

I introduce the “essential” open book foliation and apply it to study the fractional Dehn twist coefficient and tight contact structures. This is a joint work with Tetsuya Ito. (Received January 09, 2012)

1079-57-158 **Iain Moffatt*** (imoffatt@jaguar1.usouthal.edu), Mathematics and Statistics, University of South Alabama, Mobile, AL 36688. *Characterizing the ribbon graphs of knots*.

There is a well-known way to describe a link diagram as a (signed) plane graph, called its Tait graph. This concept was recently extended, providing a way to associate a set of embedded graphs (or ribbon graphs) to a link diagram. While every plane graph arises as a Tait graph of a unique link diagram, not every embedded graph represents a link diagram. Furthermore, the same embedded graph can represent many link diagrams. Here we characterize the class of embedded graphs that represent link diagrams. This characterization is then used to relate all of the link diagrams that give rise to the same set of embedded graphs. (Received January 11, 2012)

1079-57-198 **Sam Nelson*** (sam.nelson@cmc.edu). *Polynomial birack modules and their link invariants*. Preliminary report.

Birack modules over polynomial rings define invariants of birack-labeled link diagrams which may be understood as customized Alexander polynomials; we use these to define a new enhancement of the birack counting invariant. (Received January 12, 2012)

1079-57-205 **Louis H. Kauffman*** (kauffman@uic.edu), Math UIC, 851 South Morgan Street, Chicago, IL 60607-7045. *Genus of Virtual Knots*.

This talk will be a progress report on studying the genus of virtual knots and links. The genus of a virtual link is the least genus surface in which it can be represented as a diagram representing a link in that surface crossed with the unit interval. (Received January 13, 2012)

1079-57-211 **Carmen L Caprau***, Department of Mathematics, 5245 N. Backer Avenue M/S PB 108, Fresno, CA 93740. *On a cohomology theory for colored tangles*. Preliminary report.

We will introduce a triply graded cohomology theory for (colored) oriented framed tangles whose strands are labelled by irreducible representations of quantum $\mathfrak{sl}(2)$. Restricting to closed tangles, more precisely to knots, the total graded Euler characteristic of the resulting invariant of the closed tangle/knot is the colored Jones polynomial of the knot. (Received January 13, 2012)

1079-57-212 **Boris Goldfarb*** (goldfarb@albany.edu). *Parametrized controlled algebra and its applications*. Preliminary report.

Controlled algebra has been used extensively to model the K-theory of group rings for infinite groups. I will show a fibered version of the theory, where the control is allowed to vary along with a parameter, and its applications to the study of assembly maps. (Received January 13, 2012)

1079-57-215 **Allison Henrich*** (henricha@seattleu.edu), 901 12th Ave, Seattle, WA 98118, and **Alissa Crans** and **Sam Nelson**. *Virtual Knot Invariants from the Alexander Biquandle: A Groebner Basis Approach*.

The Alexander virtual biquandle of a virtual knot or link is a module over a 2-variable Laurent polynomial ring which is an invariant of virtual knots and links. The elementary ideals of this module are then invariants of virtual isotopy which determine both the generalized Alexander polynomial (also known as the Sawollek polynomial) for virtual knots and the classical Alexander polynomial for classical knots. For a fixed monomial ordering $<$, the Groebner bases for these ideals are computable, comparable invariants which fully determine the elementary ideals and which generalize and unify the classical and generalized Alexander polynomials. We will look at examples and discuss future directions for this work. (Received January 13, 2012)

1079-57-223 **Moshe Cohen** and **Adam Lowrance*** (adam-lowrance@uiowa.edu), 14 MacLean Hall, University of Iowa, Iowa City, IA 52242. *A categorification of the Tutte polynomial*. Preliminary report.

We construct a categorification of the Tutte polynomial for graphs and matroids. Our categorification is a triply-graded vector space whose graded Euler characteristic is the Tutte polynomial. We discuss generalizations of the

deletion-contraction and duality formulas for the Tutte polynomial. We also show how to obtain an invariant of alternating knots and discuss a possible relationship with Khovanov homology. (Received January 14, 2012)

1079-57-229 **Jozef H. Przytycki*** (przytyck@gwu.edu), Department of Mathematics, George Washington University, Washington, DC 20052. *Conway algebras, Tutte algebras, and invariants of links.*

A Conway algebra, introduced by Pawel Traczyk and the speaker in December 1984, is a magma $(A, *)$ with invertible $*$: $X \times X \rightarrow X$ (that is $*$: $A \times \{b\} \rightarrow A$ is invertible), satisfying entropic condition $(a * b) * (c * d) = (a * c) * (b * d)$, with a sequence of constants $a_n \in A$ satisfying $a_n * a_{n+1} = a_n$ for every n . We demonstrated (with Traczyk) that every Conway algebra yields a link invariant (which we called algebraic invariant of Conway type). The main example is the Homflypt polynomial. In fact, the Murdoch-Toyoda theorem guarantee that if $(A, *)$ is a quasigroup than the invariant is a variant of the Homflypt polynomial. In the joint paper with M.Niebrzydowski and M.Dabkowski we use Conway algebras and related Tutte algebras (i.e. Kauffman bracket skein relation is used in place of Conway skein relation) to approach the 4-move conjecture of Nakanishi and Kawachi. We also discuss use of Conway algebras to study virtual links. (Received January 15, 2012)

1079-57-230 **Alexander M Zupan*** (alexander-zupan@uiowa.edu), 14 MacLean Hall, Department of Mathematics, Iowa City, IA 52242. *Bridge splittings, the pants complex, and hyperbolic volume.*

Every knot K in a 3-manifold M can be decomposed via a bridge splitting; that is, (M, K) can be expressed as the union of two simple pieces along a surface. Using the topology of the attaching map, we may define an integer complexity of such a splitting using the pants complex related to the bridge surface. In the case that K is hyperbolic, we discuss evidence of a relationship between this complexity and the volume of the complement of the knot. (Received January 15, 2012)

1079-57-233 **R. Taylor McNeill*** (rtm2@rice.edu), Mathematics Department, MS 136, Rice University, 6100 Main St, Houston, TX 77005. *A new filtration of the Magnus kernel of the Torelli group.*

For a surface Σ , the Torelli group is the group of orientation preserving homeomorphisms of Σ that induce the identity on homology. The Magnus representation represents the action on F/F'' where $F = \pi_1(\Sigma)$. For many years it was unknown whether the Magnus representation of the Torelli group is faithful. In recent years there have been many developments on this front including the result of Church and Farb that the kernel of the Magnus representation, denoted K , is infinitely generated. I show that, not only is K highly non-trivial but that it also has a rich structure as a group. Specifically, I define an infinite filtration of K by subgroups, called the higher-order generalized Johnson subgroups. I show that for each n , there are elements in the n^{th} term but not the next term of the filtration. To do this, I define a higher-order generalized Johnson type homomorphism on each new subgroup and show it has a non-trivial image. (Received January 15, 2012)

1079-57-251 **Uwe Kaiser*** (kaiser@math.boisestate.edu), Department of Mathematics, 1910 University Drive, Boise, ID 83725-1555. *Relating the Jones and Kauffman bracket skein modules of oriented 3-manifolds.* Preliminary report.

We define and discuss epimorphisms from Jones skein modules onto Kauffman bracket skein modules. This is generalizing Kauffman's normalization of the Kauffman bracket of a planar diagram to get the Jones polynomial. The main ingredient is the definition of a writhe invariant of framed 1-manifolds in oriented compact 3-manifolds. This is related to work of Przytycki on the q -analogue of the first homology group. (Received January 16, 2012)

1079-57-258 **Jack S Calcut*** (jcalcut@oberlin.edu), Department of Mathematics, Oberlin College, Oberlin, OH 44074. *Artin presentations.*

Artin presentations are discrete equivalents of planar open book decompositions of arbitrary closed orientable 3-manifolds. Artin presentations characterize the fundamental groups of such 3-manifolds (a result of Gonzalez-Acuna). AP theory has a canonical knot theory which is group theoretic and completely general. AP theory also gives a nontrivial relationship between combinatorial group theory and smooth 4-dimensional topology. (Received January 16, 2012)

1079-57-298 **Kenneth L Baker*** (k.baker@math.miami.edu), Department of Mathematics, University of Miami, Coral Gables, FL 33146, **Dorothy Buck** (d.buck@empirical.ac.uk), Department of Mathematics, Imperial College London, 180 Queens Gate, London, SW7 2AZ, England, and **Ana Lecuona** (lecuona@math.psu.edu), 308 McAllister Bldg, Department of Mathematics, Penn State University, University Park, PA 16802. *Slicing two-bridge links*. Preliminary report.

In the process of showing which lens spaces bound rational homology balls, Lisca showed which two-bridge links are slice. For some slice two-bridge links, but not all, he demonstrated sliceness by a single banding from the two-bridge link to the two component unlink. We show that indeed every slice two-bridge link may be transformed to the unlink by a single banding and moreover some may be done in multiple ways. Viewed in terms of double branched covers, this work proposes a classification of knots in $S^1 \times S^2$ with lens space surgeries. (Received January 17, 2012)

1079-57-299 **Mark Powell***, IU Department of Mathematics, Rawles Hall, 831 E 3rd Street, Bloomington, IN 47401. *Two new uses for the Alexander module*.

Defined in the 1920s, the classical Alexander module remains potent. I'll talk about two projects, joint work with Stefan Friedl, and with Cheryl Balm, Stefan Friedl and Effie Kalfagianni, which share the common theme of finding new applications for the Alexander module. (Received January 17, 2012)

1079-57-304 **Daniel S Silver*** (silver@jaguar1.usouthal.edu), Department of Math and Stat, ILB 325, University of South Alabama, Mobile, AL 36688, and **Susan G Williams** (swilliam@jaguar1.usouthal.edu), Dept of Math and Stat, ILB 325, University of South Alabama, Mobile, AL 36688. *Twisted Links and Alexander Invariants*.

Let $L = \ell_1 \cup \dots \cup \ell_{d+1}$ be an oriented link in the 3-sphere, and let $L(q)$ be the d -component link $\ell_1 \cup \dots \cup \ell_d$ regarded in the homology 3-sphere that results from performing $1/q$ -surgery on ℓ_{d+1} . Results about the Alexander polynomial and twisted Alexander polynomials of $L(q)$ corresponding to finite-image representations are presented. The behavior of the invariants as q increases without bound is described. (Received January 17, 2012)

1079-57-318 **Jennifer Hom*** (hom@math.columbia.edu). *Applications of the knot Floer complex to concordance*. Preliminary report.

By considering the knot Floer complex up to the weaker relation of epsilon-equivalence, rather than filtered chain homotopy equivalence, one can obtain a wealth of concordance information. We will discuss applications of this approach. (Received January 17, 2012)

1079-57-319 **Susan G Williams*** (swilliam@jaguar1.usouthal.edu), Dept. Math and Stat, ILB 325, University of South Alabama, Mobile, AL 36688, **Daniel S Silver** (silver@jaguar1.usouthal.edu), Dept Math and Stat, ILB 325, University of South Alabama, Mobile, AL 36688, and **J Scott Carter** (carter@jaguar1.usouthal.edu), Dept of Math and Stat, ILB 325, University of South Alabama, Mobile, AL 36688. *Surface Link Groups*.

A virtual link can be regarded as an equivalence class of a link L embedded in a thickened surface $S \times I$, under a suitable equivalence relation. Given a representative $L \subset S \times I$, we define a group π_L by lifting L to the universal cover of $S \times I$ and considering the fundamental group of its complement. The group π_L is a finitely presented operator group (in the sense of Noether) with operator set equal to $\pi_1 S$. It is a natural generalization of the group of a classical link. As an application, we give a short proof that the Kishino knot has virtual genus 2. (Received January 17, 2012)

1079-57-322 **Ying Hu*** (yhu4@math.lsu.edu). *Representations of the knot group and the cyclic branched covers*. Preliminary report.

Given a knot K , consider $SL(n, \mathbb{C})$ representations of the knot group $\pi_1(X_K)$ satisfying the condition that for some $k \in \mathbb{Z}$, M^k is sent to $-I$, where M is the meridian in the knot group $\pi_1(X_K)$. We built a one-to-one correspondence between conjugacy classes of $\{\rho \in \text{Hom}(\pi_1(X_K), SL(n, \mathbb{C})) : \rho(M)^k = -I\}$ and a certain subset of $SL(n, \mathbb{C}) \times \text{Hom}(\pi_1(M_k), SL(n, \mathbb{C}))$, where M_k is the k^{th} cyclic branched cover of S^3 over the knot K . In particular, as $k = 2$, such representations of the knot group $\pi_1(X_K)$ which map M^2 to $-I$ are *traceless* representations. (Received January 18, 2012)

- 1079-57-326 **Abhijit Champanerkar*** (abhijit@math.csi.cuny.edu), Department of Mathematics, College of Staten Island, CUNY, 2800 Victory Boulevard, Staten Island, NY 10314, and **Ilya Kofman** (ikofman@math.csi.cuny.edu), Department of Mathematics, College of Staten Island, CUNY, 2800 Victory Boulevard, Staten Island, NY 10314. *On the tail of Jones polynomials of closed positive braids with a full twist.*

We discuss stability of coefficients of colored Jones polynomials which has been a topic of recent interest. For closed positive braids with a full twist we determine the tail of the Jones polynomials and deduce stability for this class of links. (Received January 17, 2012)

- 1079-57-330 **Tim D Cochran*** (cochran@rice.edu). *On the injectivity of satellite operations in knot concordance.* Preliminary report.

Satellite operations with a fixed pattern may be viewed as functions from the set of knot types to the set of knot types. Using standard tools of 3-manifolds one can see that these functions are usually injective. These functions descend to give operators (not homomorphisms) on the set of smooth concordance classes of knots. It is conjectured that many of these are also injective. The Whitehead Double operator is the most famous example. Despite growing evidence, to date no non-trivial operator has been shown to be injective. We will prove that for a very large class of operators, P , modulo the smooth 4-d Poincaré conjecture, $P(K)=P(\text{Unknot})$ implies $K=\text{Unknot}$. For topological concordance the hypothesis about the Poincaré conjecture is not needed. (Received January 17, 2012)

- 1079-57-334 **M Kate Kearney*** (kearney@lsu.edu). *An obstruction to knots bounding Mobius bands in B^4 .*

The relationship between embedded surfaces and their knotted boundaries has been one of the main topics of knot theory for much of the last half century. This talk focuses on a particular case, namely whether a given knot in the three-sphere can be the boundary of a Mobius band embedded in the four-ball, B^4 . We will discuss a new example of a knot which does not bound a Mobius band in B^4 , and describe how the d -invariant of Heegaard-Floer theory is used to obstruct this and other knots from bounding Mobius bands in B^4 . (Received January 17, 2012)

- 1079-57-342 **Prudence Heck*** (ph6@rice.edu), Rice University, Department of Mathematics, 6100 S. Main St., Houston, TX 77005, and **Tim Cochran**. *Topologically slice knots with small fundamental group.* Preliminary report.

A well known result of Freedman states that knots in S^3 with trivial Alexander polynomial are topologically slice. His proof depends on the disk embedding theorem, which is only known to hold for 4-manifolds with “good” fundamental group. In this talk we will discuss necessary conditions for the exterior of a topologically flat disk in B^4 to have good fundamental group. In particular, we give a complete characterization of all genus one knots that are homotopy ribbon wherein the group of the exterior of the slice disk is metabelian. (Received January 17, 2012)

- 1079-57-350 **Ina Petkova*** (ina@math.columbia.edu), Dept of Mathematics, Columbia University, Room 509, MC 4406 2990 Broadway, New York, NY 10027. *Bordered Floer homology and applications to knots.*

Bordered Floer homology is a Floer theory for manifolds with parametrized boundary that recovers Heegaard Floer homology under gluing. I will briefly describe the general bordered Floer theory, then focus on properties of the bordered Floer complex in the case of torus boundary, and talk about applications to knot theory. (Received January 17, 2012)

- 1079-57-359 **Susan Abernathy*** (sabern1@tigers.lsu.edu). *Obstructions to embedding torus tangles in links.* Preliminary report.

A tangle T contained in the 3-ball embeds in a link L in S^3 if there is a 3-ball $B \subset S^3$ such that $B \cap L$ is the tangle T . More generally, one can extend the notion of tangle embedding to tangles contained in another submanifold of the 3-sphere, such as an unknotted solid torus. We refer to tangles inside an unknotted solid torus as *torus tangles*, and discuss some obstructions to embedding torus tangles in links. (Received January 17, 2012)

- 1079-57-374 **Shelly Harvey*** (shelly@rice.edu), **Tim Cochran** and **Peter Horn**. *Filtering Smooth Concordance classes of Topologically Slice Knots.*

The n -solvable filtration of the smooth knot concordance group, due to Cochran-Orr-Teichner, is flawed in the sense that any topologically slice knot lies in every term of the filtration. In order to correct this we define and

investigate a new filtration of the smooth knot concordance group and show that the quotients of each of its successive terms have infinite rank. Our primary interest is in the induced filtration, $\{T_n\}$, on the subgroup, T , of knots that are topologically slice. We prove that T/T_0 is large, detected by gauge-theoretic invariants and the τ , s , and δ -invariants; while T_0/T_1 is detected by certain d -invariants. Going beyond this, our main result is that T_1/T_2 has rank at least one. Under a weak ‘‘homotopy-ribbon’’ condition, we show that each of the higher terms T_n/T_{n+1} has positive rank. Our filtration is simultaneously a refinement of the n -solvable filtration and a generalization of notions of positivity due to Gompf and Cochran. (Received January 18, 2012)

1079-57-375 **Gilbert Baumslag** (gilbert@groups.sci.ccnycuny.edu), Convent Avenue and 138th Street, City College of New York, New York, NY 10031, **Roman Mikhailov** (rmikhailov@mail.ru), Gubkina 8, Steklov Mathematical Institute, Moscow, 117966, Russia, and **Kent E Orr*** (korr@indiana.edu), 831 E. 3rd Street, Indiana University, Bloomington, IN 47401. *Groups and their lower central series quotients*. Preliminary report.

Stallings Theorem implies that the lower central series quotients of a fundamental group are invariant under homology cobordism of a space. This underlies Milnor’s link invariants, for instance, but analogues hold for knots in arbitrary 3-manifolds.

We investigate a problem posed by Magnus. What does the lower central quotients of a finitely generated, residually nilpotent group tell us about the group? (Received January 18, 2012)

1079-57-379 **Sergei Chmutov*** (chmutov@math.ohio-state.edu), 1760 University Drive, Mansfield, OH 44906. *Evaluations of the Tutte-Krushkal-Renardy polynomial for cell complexes*. Preliminary report.

Recently V.Krushkal and D.Renardy generalized the Tutte polynomial from graph to simplicial and cell complexes. We show that evaluation of this polynomial at the origin gives the number of cellular spanning trees in a sense of A.Duval, C.Klivans and J.Martin. Moreover, a slight modification of the Krushkal-Renardy polynomial lead to the weighted cellular spanning trees and therefore can be calculated by the cellular matrix-tree theorem. In the case of cell decomposition of a sphere this modified polynomial also satisfies the duality relation of Krushkal-Renardy. Another evaluation of the Tutte-Krushkal-Renardy polynomial is the Bott polynomials introduced by Raoul Bott in 1952. (Received January 18, 2012)

1079-57-382 **Cameron McA. Gordon***, gordon@math.utexas.edu, and **Steven Boyer** and **Liam Watson**. *L-spaces and left-orderability*.

We will discuss evidence for the conjecture that a rational homology 3-sphere is an L-space if and only if its fundamental group is not left-orderable. (Received January 18, 2012)

1079-57-384 **Clayton Shonkwiler*** (clayton@math.uga.edu), UGA Mathematics Department, Boyd GSRC, Athens, GA 30602, and **Frederick R. Cohen** and **Rafal Komendarczyk**. *Homotopy periods of link maps and Milnor’s invariants*. Preliminary report.

I will outline the proof of a homotopy-theoretic interpretation of the Milnor invariants of Brunnian links which seems well-adapted to generalization. (Received January 18, 2012)

1079-57-388 **Heather M. Russell*** (heathemr@usc.edu), **Matthew Housley** and **Julianna S. Tymoczko**. *Symmetric group actions on webs*.

By specializing the q parameter in the sl_2 and sl_3 spider categories, we obtain a symmetric group action on a certain subcollection of webs. This action is known to be irreducible, but the relationship between the web basis and other bases for symmetric group representations is not well understood. Using an explicit bijection between Young tableaux and webs, we will discuss various features of the web basis. (Received January 18, 2012)

1079-57-407 **Christopher William Davis*** (cwd1@rice.edu), 1710 Wroxtton Ct., Apt 1, Houston, TX 77005. *Computing first order signatures and making a construction of Cochran-Harvey-Leidy explicit*.

The solvable filtration of the knot concordance group has been studied closely since its definition by Cochran, Orr and Teichner in 2003. Recently Cochran, Harvey and Leidy have shown that the successive quotients in this filtration contain infinite rank free abelian groups and even exhibit a kind of primary decomposition. Unfortunately, their construction relies on an assumption of non-vanishing of certain ρ -invariants. By relating these ρ -invariants to the signature function of Cimasoni-Florens, we remove this ambiguity from the construction of Cochran-Harvey-Leidy. (Received January 18, 2012)

1079-57-409 **Taylor E Martin*** (taylor.martin@rice.edu). *Classification of 0-solvable links.*
 The n -solvable filtration, defined by Cochran, Orr, and Teichner in the late 90's, gives structure to the smooth knot and link concordance groups. Much is known about the n -solvable filtration of the knot concordance group for small n . For example, a knot is 0-solvable if and only if it has Arf invariant zero. Moreover, a knot is 0.5-solvable precisely when it's Seifert matrix looks like that of a slice knot, called algebraically slice. However, very little is known for links. In this talk, we will discuss a classification of 0-solvable links. (Received January 18, 2012)

1079-57-417 **Thomas E. Mark*** (tmark@virginia.edu), Department of Mathematics, PO Box 400137, University of Virginia, Charlottesville, VA 22903. *Constructions of symplectic 4-manifolds via local Lefschetz fibrations.*
 Joint work with David Gay has led to a fairly general procedure for producing 4-dimensional symplectic cut-and-paste operations, based on the idea of monodromy substitution in Lefschetz fibrations defined locally in a manifold. We describe a variety of instances of this construction, with a view toward producing new "interesting" symplectic 4-manifolds. (Received January 18, 2012)

1079-57-420 **Cody Armond*** (carmond@math.lsu.edu), Louisiana State University, Department of Mathematics, 303 Lockett Hall, Baton Rouge, LA 70803, and **Oliver T Dasbach**, Louisiana State University, Department of Mathematics, 303 Lockett Hall, Baton Rouge, LA 70803. *Adequate Knots and the Colored Jones Polynomial.* Preliminary report.
 The colored Jones polynomial is a sequence of Laurent polynomials. We show that for adequate links, which is a class containing all alternating links, the leading coefficients stabilize in a way that we can define power series called the head and tail of the colored Jones polynomial. We also show properties of the head and tail, including a classification of exactly which adequate links have trivial head or tail. (Received January 18, 2012)

1079-57-431 **Oliver T Dasbach***, Mathematics Department, 306 Lockett Hall, Louisiana State University, Baton Rouge, LA 70803, and **Cody Armond**. *A product on prime alternating knots, and the colored Jones polynomial.* Preliminary report.
 We study a product on prime alternating knots that corresponds to a certain plumbing of state surfaces that span the knot, and the effect on the colored Jones polynomial. (Received January 18, 2012)

1079-57-442 **James Conant*** (jconant@math.utk.edu), Knoxville, TN 37996, and **Robert Schneiderman** and **Peter Teichner**. *Iterating the Whitney move.*
 The Whitney move allows one to remove pairs of algebraically canceling intersections of an n -manifold embedded in a $(2n)$ -manifold, where $n > 2$. It is well-known to fail when the ambient dimension is 4 because the Whitney disk that guides the move is not generically embedded. This leads to the idea of a Whitney towers, where one can pair the intersections of Whitney disks by "higher-order" Whitney disks, and repeat the process with these Whitney disks. We give a complete list of obstructions for a link in S^3 to bound a Whitney tower of order n into the 4-ball, in terms of Milnor invariants, higher-order Sato-Levine invariants and higher-order Arf invariants. (Received January 19, 2012)

58 ► *Global analysis, analysis on manifolds*

1079-58-216 **John Ryan*** (jryan@uark.edu), Department of Mathematical Sciences, University of Arkansas, Fayetteville, AR 72703, and **Stuart Shirrell**. *Symmetry in Hermitian Clifford Analysis.* Preliminary report.
 Hermitian Clifford analysis has arisen as an attempt to marry together euclidean Clifford analysis and almost complex structures. We will show that this extensively limits the group of invariances for the resulting Dirac type operators. This is joint work with Stuart Shirrell. (Received January 13, 2012)

60 ► *Probability theory and stochastic processes*

1079-60-68 **Sivaguru S Sritharan*** (sssritha@nps.edu), Naval Postgraduate School, Monterey, CA 93943. *THE STOCHASTIC NAVIER-STOKES SEMIMARTINGALE: SOLVABILITY, CONTROLS & LARGE DEVIATIONS.*

In this talk we will consider incompressible and compressible fluid dynamics subject to jump noise modeled by stochastic Navier-Stokes equations with Levy noise forcing. The mathematical problem is that of an infinite dimensional cadlag valued semimartingale whose solvability can be characterized through pathwise strong solutions and martingale solutions for the probability law. Existence of martingale solutions can be proven by generalizing M. Metivier's techniques of semimartingales on Lusin spaces and tightness of measures. We will also describe control theoretic aspects of the model as well as large deviation theorems. Large deviation theory for the small noise limit as well as long time limit and Donskar-Varadhan theory are of interest in this context and we will describe what is accomplished and outline open problems. (Received December 15, 2011)

1079-60-97 **Yuan Zhou*** (zhouy@mail.usf.edu), 14233 Les Plams Cir Apt 202, Tampa, FL 33613, and **Zhe Wu**, Peoples Rep of China. *Mean-variance Portfolio Selection with Margin Requirements.*

This paper is concerned with the continuous-time Markowitz mean-variance portfolio selection in the presence of margin requirements for short-selling.

Let $v > 0$ be initial wealth and $\pi_i(t)$ be time t total wealth of i th asset, then the wealth process satisfy

$$\begin{cases} dX(t) = \left\{ r(t)X(t) + \pi^T(t)[b(t) - r(t)\vec{1}] - \lambda r(t) \sum_{i=1}^d \pi_i^- \right\} dt + \pi^T(t)\sigma(t)dW(t), & t \in [0, T], \\ X(0) = v. \end{cases}$$

The mean-variance problem is to minimize $\text{var}[X(T)]$ subject to $E[X(T)] = \mu$.

This problem can be formulated as a stochastic non-linear quadratic control problem and is solved with the help of HJB equation by using viscosity solution method. Finally we get the formula for optimal portfolio and efficient frontier. (Received January 07, 2012)

1079-60-103 **M. Sambandham*** (msamband@morehouse.edu), Department of Mathematics, Morehouse College, Atlanta, GA 30314. *Roots of Real Random Polynomials on the Real Axis.* Preliminary report.

We consider a family of real random polynomials of degree n with dependent Gaussian random coefficients and exponentially decreasing variance. For such real random polynomials we estimate the asymptotic value of the mean number of real roots for large n . (Received December 29, 2011)

1079-60-129 **Tyrone E. Duncan*** (duncan@math.ku.edu), Mathematics Dept., Snow Hall, University of Kansas, 1460 Jayhawk Blvd., Lawrence, KS 66045. *Linear-Quadratic Control of Stochastic Partial Differential Equations with Fractional Brownian Motions.*

A control problem for a linear stochastic equation in a Hilbert space that is driven by a Hilbert space-valued fractional Brownian motion and for a quadratic cost functional in the state and the control is formulated and solved. An optimal control is given explicitly that is the sum of the well known linear feedback control from deterministic linear systems and a prediction of the response of an optimal dual system to the future fractional Brownian motion. These stochastic equations can describe some stochastic partial differential equations (SPDEs) where the control and the noise can be restricted to discrete points in the domain or to the boundary of the domain. The optimal control is obtained by expressing the cost as the square of an affine function of a control from which an optimal control follows directly. This solution method allows for the use of noise processes other than fractional Brownian motions. Some examples of SPDEs are given that can be used. This is joint work with B. Maslowski and B. Pasik-Duncan. (Received January 05, 2012)

1079-60-134 **Qi Zhang*** (qzh@fudan.edu.cn), School of Mathematical Sciences, Fudan University, Shanghai, 200433, Peoples Rep of China. *The Stationary Solutions of Parabolic SPDEs via Backward Doubly SDEs.*

In this talk, I would like to introduce our work on the stationary solutions of parabolic SPDEs. Our method utilizes the connection between parabolic SPDEs and backward doubly SDEs. To get the existence of stationary solutions of parabolic SPDEs, we first prove the existence and uniqueness of weak solutions of parabolic SPDEs by their connection with backward doubly SDEs. Then we study the stationary property of the solutions of backward doubly SDEs, which can be transferred to the corresponding SPDEs so as to construct the stationary

solutions of SPDEs. This is a joint work with Huaizhong Zhao at Loughborough University. (Received January 07, 2012)

1079-60-139 **Liqun Fang** and **P. Sundar*** (sundar@math.lsu.edu), Department of Mathematics, Louisiana State University, Baton Rouge, LA 70803, and **Frederi Viens**. *Stochastic Navier-Stokes and related equations with fractional Brownian noise.*

The perturbation of the two-dimensional stochastic Navier-Stokes (and MHD) system by a Hilbert-space-valued fractional Brownian noise is considered in this talk. With noise being additive, the system is split into a deterministic nonlinear PDE, and a linear stochastic PDE. Existence and uniqueness of mild solutions are established under suitable conditions on the noise intensities for all Hurst parameter values. Further properties and extensions will briefly be described. (Received January 08, 2012)

1079-60-146 **Adina Oprisan*** (aoprisan@mail.barry.edu), Barry University, Department of Mathematics and Computer Scienc, 11300 NE 2nd Avenue, Miami Shores, FL 33161, and **Andrzej Korzeniowski**. *Large deviations for additive functionals of Markov processes.*

We consider additive functionals of Markov processes of the form $S(t) = \int_0^t f(X_s) ds$ and prove that the functional central limit theorem for additive functionals of Markov processes (Bhathacharya, 1982) admits an almost sure version based on empirical measures with logarithmic average associated with the additive functionals $\frac{1}{\sqrt{n}} \int_0^{nt} f(X_s) ds$. We further prove a Donsker-Varadhan type of large deviation principle for these empirical measures and show that the rate function coincide with the rate function for the empirical measures associated with a Wiener process. Examples, including the Ornstein-Uhlenbeck process, are provided. (Received January 09, 2012)

1079-60-168 **Olusegun M Otunuga*** (otunuga@mail.usf.edu), Department of Mathematics and Statistics, University of South Florida, 4202 East Fowler Avenue, Tampa, FL 33620, and **Gangaram S Ladde** (gladde@usf.edu), Department of Mathematics and Statistics, University of South Florida, 4202 East Fowler Avenue, PHY 114, Tampa, FL 33620. *Development of Stochastic Model by Using Natural Gas Price Data.* Preliminary report.

In this work, we initiate the development of a stochastic model of the natural gas pricing process by using the natural gas price data set. A two-factor stochastic model for dynamic of natural gas pricing process is proposed. The development of the proposed model is based upon statistical data analysis. (Received January 11, 2012)

1079-60-184 **Jinniao Qiu*** (071018032@fudan.edu.cn). *On Backward Doubly Stochastic Differential Evolutionary System.*

This talk is concerned with backward doubly stochastic differential evolutionary systems (BDSDESs for short). By using a variational approach based on the monotone operator theory, we prove the existence and uniqueness of the solutions for these BDSDESs. We also establish an Itô formula for the Banach space-valued BDSDESs. (Received January 12, 2012)

1079-60-204 **Meng Xu*** (mxu@rockefeller.edu) and **Sivaguru Sri Sritharan** (sssri@nps.edu). *A stochastic Lagrangian particle model and nonlinear filtering for three dimensional Euler flow with jumps.*

In this talk I will introduce a stochastic Lagrangian particle model with jumps for the three dimensional Euler flow and study the associated nonlinear filtering problem. We apply results from backward integro-differential equation problem to prove uniqueness of solution to the Zakai equation. (Received January 12, 2012)

1079-60-217 **Divine Wanduku*** (wandukudivine@yahoo.com), 4202 East Fowler Avenue, PHY, Tampa, FL 33620-5700, and **Gangaram Ladde**. *GLOBAL ANALYSIS OF A STOCHASTIC TWO-SCALE NETWORK HUMAN EPIDEMIC DYNAMIC MODEL WITH VARYING IMMUNITY PERIOD.*

The recent rapid spread of infectious diseases of humans are closely associated with the complex human population spatial structure and the underlying large-scale inter-patch connection human transportation. Furthermore, the disease endemicity fluctuations within patch dwelling populations are closely related with the hereditary features of the disease. We present a stochastic SIR delayed dynamic epidemic process in a two-scale population dynamic structure. The disease confers natural immunity to recovered individuals with varying immunity time lengths. The immunity time delay accounts for the time-lag during which recovered individuals with natural immunity become susceptible. We investigate the stochastic asymptotic stability of the disease free equilibrium of the two-scale structured mobile population, and the impact on the emergence, propagation and resurgence of the disease. The presented results are demonstrated by numerical simulation results. (Received January 13, 2012)

1079-60-220 **R.I.P Wickramasinghe*** (indika.wickramasinghe@ttu.edu), TX , and **A A Trindade**. We present a comparison of distributions of Moving Average model of order 1, MA(1). Here the consideration is given to three estimators of MA(1) parameter and saddlepoint approximations are used to estimate distributions. Three estimators we consider are the method of moments (MOME), the conditional least squares (CLSE) and the maximum likelihood (MLE). The estimator of the parameter can be expressed as the root of an estimating equation, which is a quadratic form in normal random variables. This is known as quadratic estimating equation (QEE). Saddlepoint approximations of the probability density function (PDF) of MA(1) estimator for MOME, CLSE and MLE is obtained and compared with their simulated counterparts. Luganni and Rice (1980) formula is used to obtain the cumulative distribution function (CDF) of MA(1) estimator. Distribution comparison of above estimators are conducted with their asymptotic distributions. Findings of Cryer and Ledolter (1981) of MLE probabilities when the parameter takes ± 1 is calculated and compared. Finally, expression of estimators in the form of quadratic estimation equation is considered for a more general case of Power Exponential (PE) random variables.
(Received January 14, 2012)

1079-60-240 **Shuya Kanagawa*** (skanagaw@tcu.ac.jp), Tokyo City University, 1-28-1 Tamazutsumi, Setagaya-ku, Tokyo, 158-8557, Japan. *A model of stock prices using a multi-dimensional reflecting Brownian motion described by the Skorohod SDE*. We introduce Euler-Maruyama approximate solutions of Skorohod SDE with reflecting boundaries on multi-dimensional domains by the penalty method. A model of stock prices is defined by the approximation of the multi-dimensional reflecting Brownian motion described by the Skorohod SDE. We apply the model to simulate simultaneously stock prices of more than two companies. Furthermore a performance of the model of stock prices is shown using some examples. (Received January 16, 2012)

1079-60-256 **Daniel Siu*** (dsiu@mail.usf.edu) and **G S Ladde** (gladde@usf.edu). *Stochastic Hybrid Dynamic Models: Parameter Estimation*. Preliminary report. Two types of real-valued stochastic hybrid systems are studied: the first-order linear homogeneous system of Ito-Doob type stochastic differential equations with jumps, and an Ornstein-Uhlenbeck system with jumps. A few estimation methods for the parameters of the discrete and continuous dynamics for the stochastic hybrid systems will be discussed. Simulated numerical examples will be given to illustrate the parameter estimation algorithms. (Received January 16, 2012)

1079-60-309 **N. Medhin*** (ngmedhin@ncsu.edu), Department of Mathematics, North Carolina State University, Raleigh, NC 27695. *Necessary conditions for stochastic programming problems*. We consider various types of stochastic programming problems and provide a unified approach to analyze them. We also point out how we can view these problems in the same way as deterministic mathematical programming problems allowing a wider range of decision variables including measures. (Received January 17, 2012)

1079-60-335 **Parisa Fatheddin*** (fatheddin@math.utk.edu), 227 Ayres Hall, 1403 Circle Drive, Knoxville, TN 37996-1320, and **Jie Xiong** (jxiong@math.utk.edu), 227 Ayres Hall, 1403 Circle Drive, Knoxville, TN 37996-1320. *Large Deviation Principle for Some Measure-Valued Processes*. Preliminary report. In much of the literature on Stochastic Partial Differential Equations (SPDE), the equations' terms are assumed to be Lipschitz continuous. In this talk a general SPDE in which the diffusion term is non-Lipschitz is considered. As an application, we derive the Large Deviation Principle for Superbrownian motion and Fleming-Viot processes. (Received January 17, 2012)

1079-60-349 **Hong Yin*** (hyin@brockport.edu), 350 New Campus Drive, Brockport, NY 14420. *Fully coupled forward-backward stochastic partial differential equations*. In this talk we study the solvability of a class of fully-coupled forward-backward stochastic partial differential equations (FBSPDEs). These FBSPDEs cannot be put into the framework of stochastic evolution equations in general, and the usual decoupling methods for the Markovian forward-backward SDEs are difficult to apply. We prove the well-posedness of the FBSPDEs, under various conditions on the coefficients, by using either the method of contraction mapping or the method of continuation. These conditions, especially in the higher dimensional case, are novel in the literature. Moreover, we show that the usual monotonicity assumption can be removed, in the case of method of continuation, by a change of the diffusion term. (Received January 17, 2012)

1079-60-383 **Xiangfeng Yang*** (xyang2@wave.tulane.edu), 327 Lauder Ave APT#1403, Moscow, ID 83843. *Large deviation expansions.*

For some families of one-dimensional locally infinitely divisible Markov processes $\{\xi_t^\epsilon\}_{0 \leq t \leq T}$ with frequent small jumps, large deviation expansions for expectations are proved: as $\epsilon \downarrow 0$

$$E^\epsilon [\exp\{\epsilon^{-1}F(\xi^\epsilon)\}] = \exp\{\epsilon^{-1}[F(\phi_0) - S(\phi_0)]\} \left(\sum_{0 \leq i \leq s/2} K_i \cdot \epsilon^i + o(\epsilon^{s/2}) \right)$$

where s is a positive integer, S is the normalized action functional, constants K_i are expressed through derivatives of the smooth functional F , and ϕ_0 is the unique maximizer of $F - S$.

The proof of above large deviation expansions relies on asymptotic expansions for expectations of a smooth functional G of stochastic processes $\eta^\epsilon = \epsilon^{-1/2}(\xi^\epsilon - \phi_0)$: as $\epsilon \downarrow 0$

$$E^\epsilon G(\eta^\epsilon) = EG(\eta) + \epsilon^{1/2}EA_1G(\eta) + \dots + \epsilon^{s/2}EA_sG(\eta) + o(\epsilon^{s/2})$$

for some Gaussian diffusion η and suitable differential operators A_i . (Received January 18, 2012)

1079-60-402 **Armando Arciniega*** (armando.arciniega@utsa.edu), **Michael Broome** and **Gaby Prieto**. *Stochastic Modeling of Parasites in Host Populations.*

The complexity of the host-parasite relationship, and its depression of host populations has been investigated and successfully modeled for large populations using deterministic methods. These models fail to accurately predict interactions within smaller populations, and require a statistical component to reclaim some degree of accuracy. This research employs stochastic differential equations to better forecast changes in small populations, and, in a practical setting, seeks to write software that will automate this procedure. (Received January 18, 2012)

1079-60-405 **Jean C Pedjeu*** (jpedjeu@mail.usf.edu) and **Gangaran S Ladde**. *Approximate solution process of multi-time scale stochastic differential equation.*

In this work, we investigate numerical approximations of multi-time scale stochastic differential equation. In particular, we analyze the approximation scheme of solutions of three time-scale stochastic differential equations, namely stochastic fractional differential equations of Ito-Doob type. Example are given to illustrate the approximation procedure. In addition, simulation results are also presented. (Received January 18, 2012)

1079-60-424 **Vindya Kumari Parhirana*** (vkumari@mail.usf.edu), Department of Mathematics and Statistics, 4202 E. Fowler Ave. , PHY 114, University of South Florida, Tampa, FL 33620-5700, and **Kandethody M Ramachandran** (ram@usf.edu), Department of Mathematics and Statistics, 4202 E. Fowler Ave. , PHY 114, Tampa, FL 33620-5700. *Nearest Neighbor Forecasting in Foreign Exchange Rates using Auto Regressive Models with Mahalanobis Distance.* Preliminary report.

Given that exchange rates series exhibit high volatility, it is widely recognized that they are extremely difficult to forecast. Besides, FX data are non-linear and one of the noisiest. Forecasting through non-linear dynamical systems is becoming more and more relevant due to these natures of the data. Nearest Neighbor Algorithms are such most popular non-linear pattern recognition methods that outperform the available linear forecasting methods. In this paper we suggest to adapt nearest neighbor algorithm with Mahalanobis distance to choose the neighbors for the forecasting. Mahalanobis distance is used due to high correlation between the vectors resulting from time series segments. Also, we suggest to adapting auto regression in the forecasting of FX rates. We compare the performance of Nearest Neighbor forecasting with Auto regression based algorithm with popular linear regression based algorithms. Also, we will show how our method affects the decision to sell and buy. (Received January 18, 2012)

1079-60-433 **G. S. Ladde** (gladde@usf.edu), Department Of Mathematics & Statistics, University of South Florida, Tampa, FL 33629, and **Ling Wu***, Department Of Mathematics & Statistics, University of South Florida, Tampa, FL 33629. *ARIMA Models Derived from Nonlinear Stochastic Differential Equations and Their Applications.*

ABSTRACT. Stochastic dynamic models are used to predict the future dynamic state of processes. This is achieved by modifying the nonlinear stochastic models from constant to time varying coefficients, and then time series ARIMA models are constructed. Using these constructed time series models, the prediction and comparison problems with the existing time series models are analyzed in the context of several data sets. The study shows that the nonlinear stochastic model 2 with time varying coefficients is robust with respect different data sets. (Received January 18, 2012)

1079-60-441 **Banu Baydil*** (banubaydil@gmail.com). *Data-driven Multi-scale Modeling of Transport in Meso-scale Oceanic Turbulence.*

A data-driven multi-scale methodology towards modeling transport in meso-scale oceanic turbulence will be introduced. The methodology will be demonstrated on a kinematic time dependent non-Gaussian random field model. The model will be calibrated through statistically extracted meso-scale flow field data. (Received January 19, 2012)

62 ► Statistics

1079-62-419 **Brian D. White*** (bdwhite@mail.usf.edu). *Applications of the Brownian Bridge and the Kolmogorov-Smirnov Test to Clustering.*

The two-sample Kolmogorov-Smirnov test is a nonparametric test for the equality of continuous, one-dimensional probability distributions that can be used to compare two independent samples. The K-S statistic is the supremum of distances that quantifies a distance between the empirical distribution functions of the two samples. The Kolmogorov distribution is the distribution of the supremum of the Brownian bridge. Under the null hypothesis, the K-S statistic converges to the Kolmogorov distribution. The test does not require specification of the hypothesized distribution yet is sensitive to differences in location and shape of the empirical distribution functions of the two samples. In insurance, the cause and nature of an injury as well as body part involved play an important role in estimating the ultimate claim size. Given the large number of possible levels, categorical variables such as these often pose a challenge to an analyst. To reduce the levels to a manageable number, clustering methods are commonly used. We present a novel approach to the use of the K-S statistic to clustering based on both location and shape. We show that this approach is often more robust than methods that focus only on location, particularly for long tail distributions such as claim sizes. (Received January 18, 2012)

65 ► Numerical analysis

1079-65-53 **kemal firat oguz*** (kemalfiratoguz@gmail.com), ege university, nuclear sciences institute, 35100 izmir, izmir, Turkey, and **a yildirim, y khan, m.a. abdou, n faraz** and **q wu**. *A numerical treatment for the solution of MHD flow over a nonlinear porous stretching sheet using HPTM-Pade technique.*

In this letter, we used the homotopy perturbation transform method (HPTM) and the Pade approximation to investigate the magnetohydrodynamic (MHD) boundary layer flow over a nonlinear porous stretching sheet. The numerical solution of the governing non-linear problem is developed. Comparison of the present solution is made with the existing solution and excellent agreement is noted. Graphical results have been presented and discussed for the pertinent parameters. The results attained in this paper confirm the idea that HPTM is powerful mathematical tool and it can be applied to a large class of linear and nonlinear problems arising in different fields of science and engineering. (Received December 11, 2011)

1079-65-70 **Yingda Cheng*** (ycheng@math.msu.edu), **Irene M Gamba** and **Phil J Morrison**. *Simulations of gravitational Vlasov-Poisson equations and the study of recurrence for the discontinuous Galerkin methods.*

In this talk, we present the recent work about the gravitational Vlasov-Poisson for the self-gravitating collisionless stellar systems. We compute the solutions using a high-order discontinuous Galerkin method for the Vlasov equation, and the classical representation by Green's function for the Poisson equation in the one-dimensional setting. We study both the case of damping and Jeans instability depending on the wavenumbers, which are taken to be greater than or less than the Jeans wavenumber, respectively. The method is shown to be stable, accurate and conservative. We report the BGK modes for the gravitational VP system and the behavior of solutions associated with these various wavenumbers. In the second part of the talk, we will consider the free streaming operator, where we performed Fourier analysis to study recurrence of the discontinuous Galerkin methods on Cartesian meshes. (Received December 16, 2011)

1079-65-70 **Leo G Rebholz*** (rebholz@clemson.edu) and **Alexander Linke**. *Recent results on discrete mass conservation in finite element methods for incompressible flow.* Preliminary report.

This talk will discuss recent results for Scott-Vogelius mixed finite elements for Navier-Stokes and related problems, grad-div stabilization, connections between SV and grad-div stabilized Taylor-Hood elements, connection

to the classical penalty method, and finally we will show a criteria for flow problems which indicates when strong enforcement of discrete mass conservation is critical. (Received December 19, 2011)

1079-65-88 **Michael Neilan*** (neilan@pitt.edu), 636 Ravencrest Rd., Pittsburgh, PA 15215.
Conforming and Divergence Free Stokes Elements.

We present a family of conforming finite elements for the Stokes problem on general triangular meshes in two dimensions. The lowest order case consists of enriched piecewise linear polynomials for the velocity and piecewise constant polynomials for the pressure. We show that the elements satisfy the inf-sup condition and converges optimally for both the velocity and pressure. Moreover, the pressure space is exactly the divergence of the corresponding space for the velocity. Therefore the discretely divergence free functions are divergence free pointwise. We also show how the proposed elements are related to a class of C^1 elements through the use of a discrete de Rham complex. This is joint work with Johnny Guzman. (Received December 21, 2011)

1079-65-154 **Yanlai Chen***, 285 Old Westport Rd, Department of Mathematics, North Dartmouth, MA 02747, and **Bernardo Cockburn**, 127 Vincent Hall, 206 Church St. SE, Minneapolis, MN 55455. *Convergence Analysis of Variable-degree HDG Methods for Convection-diffusion Equations on Nonconforming Meshes.*

We present the error analysis of hybridizable discontinuous Galerkin (HDG) methods for convection-diffusion equations with variable-degree approximations on nonconforming meshes. In particular, for approximations of degree k on all elements and conforming meshes, we show that the order of convergence of the error in the diffusive flux is $k + 1$ and that that of a projection of the error in the scalar unknown is 1 for $k = 0$ and $k + 2$ for $k > 0$. We also show that, for the variable-degree case, the projection of the error in the scalar variable is h -times the projection of the error in the vector variable. When general nonconforming meshes are used, our estimates do not rule out a degradation of $1/2$ in the order of convergence in the diffusive flux and a loss of 1 in the order of convergence of the projection of the error in the scalar variable. They do guarantee the optimal convergence of order $k+1$ of the scalar variable. However, we show these losses of orders can be *recovered* if semimatching nonconforming meshes are used. These results hold for any (bounded) irregularity index of the nonconformity of the mesh. Finally, our analysis can be extended to hypercubes. (Received January 10, 2012)

1079-65-179 **Peter Monk** and **Jiguang Sun*** (jsun@desu.edu), ETV 227, Delaware State University, 1200 N. DuPont Hwy., Dover, DE 19901. *Finite Element Methods for Maxwell's Transmission Eigenvalues.*

The transmission eigenvalue problem plays a critical role in the theory of qualitative methods for inhomogeneous media in inverse scattering theory. Efficient computational tools for transmission eigenvalues are needed to motivate improvements to theory, and, more importantly as part of inverse algorithms for estimating material properties. In this talk, we propose two finite element methods to compute a few lowest Maxwell's transmission eigenvalues which are of interest in applications. Since the discrete matrix eigenvalue problem is large, sparse, and, in particular, non-Hermitian due to the fact that the problem is neither elliptic nor self-adjoint, we devise an adaptive method which combines the Arnoldi iteration and estimation of transmission eigenvalues. Exact transmission eigenvalues for balls are derived and used as a benchmark. Numerical examples are provided to show the viability of the proposed methods and to test the accuracy of recently derived inequalities for transmission eigenvalues. (Received January 11, 2012)

1079-65-263 **Francisco-Javier Sayas*** (fjsayas@math.udel.edu), Department of Mathematical Sciences, University of Delaware, Newark, DE 19716, and **Norbert Heuer**.
Non-symmetric coupling of Interior Penalty and Boundary Element Methods.

Boundary Element Methods can be advantageously used to deal with unbounded regions in simulations where the main computational load is given to a classical PDE solver, such as the Finite Element Method. In comparison with other strategies to design absorbing boundary conditions (such as PML and Differential ABC), Boundary Integral Equations offer great geometric flexibility and exactness in the way they deal with the associated radiation condition at infinity. In this work we present a non-symmetric coupling of Boundary Elements with three variants of the Interior Penalty Discontinuous Galerkin method for diffusion problems. Until very recently, the analysis of the coupling of BEM with DG was restricted to symmetric coupling methods, that use two integral equations as a way of enforcing symmetry and relying on energy arguments for stability. However, there was numerical evidence of the good performance of the most simple-minded coupling methods, that use a single boundary integral equation to create the non-local absorbing boundary condition but pay the price of losing with the symmetry in the formulation. We show how some recently discovered tools in the analysis of

BEM-FEM can be recycled -together with finely tuned rigid scaling arguments- to prove convergence of these methods. (Received January 16, 2012)

1079-65-279 **Muhammad Usman*** (musman1@udayton.edu), 300 College Park, Dayton, OH 45469-2316. *Numerical Solution of Some Nonlinear Partial Differential Equations Using Radial Basis Functions.*

In this paper we present numerical solutions of a family of generalized fifth-order Korteweg-de Vries equations and Kuramoto-Sivashinsky Equation using a meshless method of lines. This method uses radial basis functions for spatial derivatives and Runge-Kutta method as a time integrator. This method exhibits high accuracy as seen from the comparison with the exact solutions. We will also discuss the difficulties using the method. (Received January 16, 2012)

1079-65-311 **Peijun Li*** (lipeijun@math.purdue.edu), Department of Mathematics, Purdue University, West Lafayette, IN 47907. *Generalized Foldy-Lax formulation and its application to the inverse scattering.*

We consider the scattering of a time-harmonic plane wave incident on a two-scale heterogeneous medium, which consists of scatterers that are much smaller than the wavelength and extended scatterers that are comparable to the wavelength. A generalized Foldy-Lax formulation is proposed to capture multiple scattering among point scatterers and extended scatterers. Our formulation is given as a coupled system, which combines the original Foldy-Lax formulation for the point scatterers and the regular boundary integral equation for the extended obstacle scatterers. An efficient Gauss-Seidel iterative method is proposed to solve the coupled system, where only a linear system of algebraic equations for point scatterers or a boundary integral equation for a single extended obstacle scatterer is required to solve at each step of iteration. In contrast to the standard inverse obstacle scattering problem, the proposed inverse scattering problem is not only to determine the shape of the extended obstacle scatterer but also to locate the point scatterers. Based on the generalized Foldy-Lax formulation, an imaging function is developed to visualize the location of the point scatterers and the shape of the extended obstacle scatterer. (Received January 17, 2012)

1079-65-339 **Xiaobing H Feng** (xfeng@utk.edu), Department of Mathematics, The University of Tennessee, Knoxville, TN 37996, and **Thomas L Lewis*** (tlewis@math.utk.edu), Department of Mathematics, The University of Tennessee, Knoxville, TN 37996. *Mixed and local discontinuous Galerkin methods for fully nonlinear second order partial differential equations.* Preliminary report.

In this talk we shall present some latest advances on developing discontinuous Galerkin (DG) methods for fully nonlinear second order PDEs such as the Monge-Ampere type equations and Hamilton-Jacobi-Bellman equations in the one-dimensional case. The focus of the talk is to discuss a new and general strategy for constructing such DG methods which can reliably approximate viscosity solutions of the fully nonlinear PDEs. The proposed DG methods are high order and triangular mesh generalizations of a class of finite difference methods developed by the authors for these fully nonlinear PDEs. The connection between the proposed DG methods and the finite difference methods will be explained, numerical experiment results will also be presented to gauge the performance of the proposed DG methods. If time permits, extensions to high dimensional cases and to the time-dependent PDEs will also be discussed. (Received January 17, 2012)

1079-65-386 **Cara D. Brooks*** (cbrooks@fgcu.edu). *Local Regularization Methods for Solving Inverse Problems.* Preliminary report.

Solutions of linear and nonlinear inverse problems, particularly those with special structure or for which non-smooth solutions are expected, can be effectively reconstructed using *local regularization* methods. Key features of these methods are the utilization of data most relevant to the desired solution and the non-global manner in which regularization is applied. For Volterra problems, these methods retain the causal structure of the original problem (in contrast to classical regularization methods) and lead to fast sequential numerical algorithms to solve the inverse problem. In this talk, we present advancements in the theoretical development of local regularization methods, convergence results for solving classes of linear and nonlinear Volterra inverse problems, and strategies to select the (local) regularization parameter so that convergence is achieved. (Received January 18, 2012)

1079-65-403 **Wei Guo**, Department of Mathematics, University of Houston, Houston, TX 77004, and **Jingmei Qiu*** (jingqiu@math.uh.edu), houston, TX 77004. *Super convergence of discontinuous Galerkin method: eigen-structure analysis based on Fourier approach.* Preliminary report.

In the work, we analyze the eigen-structure of the discontinuous Galerkin method for scalar linear conservation laws based on Fourier approach. Especially, we investigate (1) the dispersion and dissipation error of the physically relevant eigenvalue and (2) the eigenvector corresponding to the physically relevant eigenvalues based on Radau points. Based on our investigations, we conclude that the error of the DG solution can be decomposed as two parts. One part is due to the dispersion and dissipation error of eigenvalue; this part of error will grow linearly in time. The other part is due to the difference between the eigenvector and the corresponding waves; the magnitude of this error will not grow in time. This part of error display superconvergence at Radau points. (Received January 18, 2012)

1079-65-429 **Yulong Xing*** (xingy@math.utk.edu). *Discontinuous Galerkin method.* In this talk, we will talk about the recent development of discontinuous Galerkin method. (Received January 18, 2012)

74 ► *Mechanics of deformable solids*

1079-74-35 **Ciprian S. Borcea*** (borcea@rider.edu), Rider University, Lawrenceville, NJ 08648, and **Ileana Streinu.** *Frameworks with crystallographic symmetry.*

Periodic frameworks with crystallographic symmetry are investigated from the perspective of a general deformation theory of periodic bar-and-joint structures in R^d . It is shown that natural parametrizations provide affine section descriptions for families of frameworks with a specified graph and symmetry. A simple geometric setting for diaplacive phase transitions is obtained. Upper bounds are derived for the number of realizations of minimally rigid periodic graphs. (Received November 27, 2011)

1079-74-51 **Marjorie Wikler Senechal*** (senechal@smith.edu), Burton 211, Smith College, Northampton, MA 01063. *Icosahedra: stem cells of the solid state?* Preliminary report.

Once upon a time, not so very long ago, the regular icosahedron was exhibit A among shapes impossible for crystals. But, as the Nobel Prize Committee for Chemistry pointed out in awarding its 2011 prize, “science is a theoretical construction on an empirical fundament. Observations make or break theories.” Quasicrystals show that “icosahedral crystal” is an oxymoron no longer. But the paradigm shift these new materials have brought about goes deeper. Evidently, the icosahedron plays an important role in the growth and structure of both periodic and nonperiodic materials. In this talk I will survey theoretical and experimental work on the geometry of icosahedral clusters, and suggest that whether these clusters become glasses or quasicrystals or periodic crystals (single or twinned) depends on local material conditions, yet to be clarified. (Received December 11, 2011)

81 ► *Quantum theory*

1079-81-132 **Kaileung Chan*** (klchan@math.cuhk.edu.hk), **Conan Naichung Leung** and **Chit Ma.** *Fourier Transforms in the SYZ Programme.* Preliminary report.

The mirror symmetry conjecture says that the symplectic geometry of a Calabi-Yau manifold X is equivalent to the complex geometry of another Calabi-Yau manifold \check{X} , and vice versa. Strominger-Yau-Zaslow conjectured a geometric explanation of that: X should admit a special Lagrangian torus fibration and \check{X} can be obtained by dualizing the fibration. Moreover, the symplectic geometry of X and complex geometry of \check{X} should be interchanged through fiberwise Fourier-Mukai type transforms, with suitable modifications called quantum corrections. In this talk, we will briefly discuss the constructions of Fourier-type transforms on a torus and the dual torus, and related applications in family cases. This is a joint work with Conan Naichung Leung and Chit Ma. (Received January 06, 2012)

1079-81-135 **George A. Hagedorn*** (hagedorn@math.vt.edu), Department of Mathematics, 460 McBryde Hall, Virginia Tech, Blacksburg, VA 24061-0123. *A Simple Model for Molecular Resonance Raman Scattering.*

Molecular Raman scattering is an inelastic light scattering process. One shines laser light of a specific frequency on a molecule and looks for emitted light of a different frequency. The total energy is conserved by the molecule

changing its energy level. We present a very simple time-dependent model for predicting transition amplitudes for molecular Raman scattering associated with a laser pulse when the frequency of the incident light is resonant with an electronic transition. Our model leads to remarkably simple expressions for the transition amplitudes to leading order in both the intensity μ of the incident laser pulse and the Born–Oppenheimer parameter ϵ for the molecule. (Received January 07, 2012)

1079-81-136 **Iana I. Anguelova*** (anguelovai@cofc.edu). *\mathbb{Z}_n -graded Hopf algebras, vertex algebras and particle correspondences.* Preliminary report.

In 1+1 dimensions (1 time and 1 space dimension) the bosons and fermions are related by the boson-fermion correspondences. Twisted vertex algebras model these correspondences. The tools for constructing these examples, as well as proving formulas for the vacuum expectation values, come from \mathbb{Z}_n -graded Hopf algebras, and their twisting (Laplace pairing). In this talk we present some examples of these particle correspondences, and their underlying Hopf algebra structure. (Received January 07, 2012)

1079-81-237 **Helge Krueger*** (helge@caltech.edu), Pasadena, CA 91125. *A special class of orthogonal polynomials on the unit circle.*

I compute the support and the type of the spectrum of the orthogonal polynomials on the unit circle whose Verblunsky coefficient are given by

$$\alpha_n = \lambda \exp(2\pi i \omega n^r)$$

where $0 < |\lambda| < 1$, ω is irrational, and $r \geq 2$. Furthermore, I analyze the eigenvalue statistics in the case $r = 2$. (Received January 15, 2012)

1079-81-289 **Abdenacer Makhlouf***, 4 rue des Frères Lumière, 68093 Mulhouse, France. *Generalized Hopf algebras and Yang-Baxter equations.*

The purpose of my talk is to summarize recent developments, provide some key constructions and examples of Hom-associative and Hom-Hopf algebraic structures. The main feature of Hom-algebras is that the classical identities are twisted by a homomorphism. Moreover we show the connections to Yang-Baxter equations. (Received January 17, 2012)

82 ► *Statistical mechanics, structure of matter*

1079-82-7 **Michael W Deem*** (mwdeem@rice.edu), 6100 Main Street - MS 142, Houston, TX 77005. *A Database of Computationally-Predicted Zeolite-Like Materials.*

We here describe a database of computationally predicted zeolite-like materials. These crystals were discovered by a Monte Carlo search for zeolite-like materials. Positions of Si atoms as well as unit cell, space group, density, and number of crystallographically unique atoms were explored in the construction of this database. The database contains over 2.6M unique structures. Roughly 15% of these are within +30 kJ/molSi of alpha-quartz, the band in which most of the known zeolites lie. These structures have topological, geometrical, and diffraction characteristics that are similar to those of known zeolites. The database is the result of refinement by two interatomic potentials that both satisfy the Pauli exclusion principle. The database has been deposited in the publicly available PCOD database and www.hypotheticalzeolites.net/database/deem/. (Received August 09, 2011)

1079-82-76 **Christopher E Wilmer*** (c.wilmer@gmail.com), 2145 Sheridan Rd. TECH E136, Evanston, IL 60208, and **Randall Q Snurr**, 2145 Sheridan Rd. TECH E136, Evanston, IL 60208. *Enumerating Chemically Detailed Crystals.*

In the last decade, a wealth of novel crystalline materials have been synthesized by what has come to be called “modular” or “reticular chemistry”. This new approach, as opposed to serendipitous methods of the past, leverages the self-assembly of modular molecular “building blocks” that can only assemble in very specific orientations and allows one to design an enormous number of new crystals, far beyond what can actually be synthesized in a reasonable amount of time.

In this work, we present a novel approach of enumeratively generating all of the hypothetical crystals that can be made from a library of modular building blocks. The resulting crystals represent physical structures that can be screened in a high throughput manner via molecular simulations.

Using this method, we have generated 137,953 crystals and for each predicted a range of material properties using rapid computational simulations. In doing so, we illuminated hitherto unidentified structure-property relationships that could only have been recognized by taking a global view of the physical crystal space. (Received December 16, 2011)

1079-82-199 **Gunter Stolz*** (stolz@uab.edu), Department of Mathematics, CH 452, Birmingham, AL 35294-1170, and **Sven Bachmann**, **Bruno Nachtergaele** and **Robert Sims**. *Disordered systems of quantum harmonic oscillators*. Preliminary report.

We propose coupled harmonic oscillators as a model of a many-body quantum system in which the effect of disorder on its dynamics can be rigorously analyzed. Here disorder is introduced by randomizing system parameters such as spring constants or masses. We prove two types of results: (i) zero-velocity Lieb-Robinson bounds for the Heisenberg evolution of Weyl operators, and (ii) exponential decay of correlations for the ground state as well as for positive temperature Gibbs states. The proofs use that the many-body dynamics of an oscillator system can be reduced to the dynamics of an effective one-particle Hamiltonian (such as the Anderson model). (Received January 12, 2012)

91 ► *Game theory, economics, social and behavioral sciences*

1079-91-124 **Kandethody M Ramachandran*** (ram@usf.edu), Department of Mathematics and Statistics, University of South Florida, Tampa, FL 33620-5700. *Weak convergence methods for Ergodic stochastic differential games and a numerical method*.

Since the early development days, differential game theory has had a significant impact in such diverse disciplines as applied mathematics, economics, systems theory, engineering, operations, research, biology, ecology, environmental sciences, among others. Much of stochastic game theory is concerned with diffusion models. It is well known that such models are often only idealizations of the actual physical processes, which might be driven by a wide bandwidth process or be a discrete parameter system with correlated driving noises. Optimal strategies derived for the diffusion models would not be of much interest if they were not "nearly optimal" for the physical system which the diffusion approximates. In this presentation, we will show that the optimal strategies derived for the "limit" system are also good strategies for the system which is driven by wide bandwidth noise processes. Such results not only gives robustness statement on the game problem, but also substantially simplifies the computational aspects. , One such computational technique based on Markov chain approximation method will also be presented. (Received January 04, 2012)

1079-91-213 **Arnut Paothong*** (apaathon@mail.usf.edu), 4202 East Fowler Avenue, PHY 114, Tampa, FL 33620-5700, and **Gangaram S Ladde**, 4202 East Fowler Avenue, PHY 114, Tampa, FL 33620-5700. *Agent-Based Modeling Simulation under Local Network Externality*.

In general, the consumer utility of network goods is affected by the entire network size. The present work departs from this standard assumption. We develop network structure, structure of utility function and consumer decision rule under the influence of local network externality concept. The significance of this work is illustrated by the association between network attributes and market equilibria. In addition, we introduce an agent-based modeling simulation (ABMS) as an alternative approach to the mathematical deductive reasoning approach. (Received January 13, 2012)

1079-91-288 **Jaeyoung Sung*** (jaeyoungsung@ajou.ac.kr), Department of Financial Engineering, Ajou University, Suwon, Gyunggi-do 443-749, South Korea, and **Xuhu Wan** (imwan@ust.hk), Department of Information Systems, Business Statistics and Operations Mgt., Hong Kong U. of Science and Technology, Clear Water Bay., Kowloon , Hong Kong. *A General Equilibrium Model of a Multi-Firm Moral-Hazard Economy with Financial Markets*.

We present a general equilibrium model of a moral-hazard economy with many firms and financial markets, where stocks and bonds are traded. Contrary to the principal-agent literature, we argue that optimal contracting in an infinite economy is not about a tradeoff between risk sharing and incentives, but it is all about incentives. Even when the economy is finite, optimal contracts do not depend on principals' risk aversion, but on market prices of risks. We also show that optimal contracting does not require relative performance evaluation, that the second best riskfree interest rate is lower than that of the first best, and that the second-best equity premium can be either higher or lower than that of the first best. Based on these results, we argue that given the volatility of

the market portfolio, moral hazard can contribute to the resolution of the riskfree rate puzzle, but unlike the existing literature suggests, our model provides a case where moral hazard can neither help explain nor deepen the equity premium puzzle. (Received January 17, 2012)

92 ► *Biology and other natural sciences*

1079-92-1 **Anne Condon*** (condon@cs.ubc.ca), 2366 Main Mall, University of British Columbia, Computer Science Department, Vancouver, BC V6R 2C5, Canada. *Some why's and how's of programming DNA molecules.*

Programs that execute within cells or that create intricate structures at nano-scale resolution are now a reality—designed and implemented using DNA molecules. In this talk I'll illustrate some why's and how's of DNA programming, and I'll describe research problems with a combinatorial and algorithmic flavour that arise in this field.

Why might we program molecules? Molecular programming offers the promise of understanding and changing our world at staggeringly small scales, with applications to disease diagnosis and therapeutics.

How can we program DNA molecules? We can leverage molecular sequence, structure and folding pathways. Programs are *sequences* of A,C,G and T bases that comprise DNA molecules. DNA *structure* arises when complementary bases bind to form A-T and C-G pairs; thus sequences can be programmed to create intricate nano-scale shapes. Finally, *folding pathways* - successions of structural changes over time - support molecular movement, thereby providing ways to realize tiny DNA robots.

Research challenges of a theoretical nature that are motivated by DNA computations include: understanding the capabilities of new models of computation, predicting the behavior of interacting molecules, and designing efficient means detecting and correcting errors. (Received June 21, 2011)

1079-92-98 **Nadrian C. Seeman*** (ned.seeman@nyu.edu), Department of Chemistry, New York University, New York, NY 10003. *DNA is Not Merely the Secret of Life: Using the Chemical Information in DNA for the Construction of Objects, Lattices and Nanorobots.*

Synthetic DNA molecules can be designed that enable us to build branched DNA species. These are joined using sticky ends to produce N-connected objects and lattices. We have used ligation to construct DNA stick-polyhedra and topological targets, such as Borromean rings. We have constructed 2-dimensional DNA arrays with designed patterns from many different motifs. DNA arrays have been used to organize gold nanoparticles in specific arrangements in 2D and 3D. We have made a self-replicating 1D arrangement of DNA motifs. We have made robust sequence-dependent devices that change states by varied hybridization topology. Bipedal walkers, both clocked and autonomous have been built. We have constructed a molecular assembly line with three 2-state devices, so that there are eight different states represented by their arrangements. Recently, we have self-assembled a 3D crystalline array and have solved its crystal structure to 4 Å resolution, using unbiased crystallographic methods. We can use crystals with two molecules in the crystallographic repeat to control the color of the crystals. Thus, structural DNA nanotechnology has fulfilled its initial goal of controlling the structure of matter in three dimensions. A new era in nanoscale control awaits us. (Received December 26, 2011)

1079-92-101 **Edward J. Allen*** (edward.allen@ttu.edu), Department of Mathematics and Statistics, Texas Tech University, Lubbock, TX 79409-1042. *Derivation and Computation of Discrete-Delay and Continuous-Delay SDE Models in Mathematical Biology.* Preliminary report.

Stochastic versions of discrete-delay and continuous-delay differential equations, useful in mathematical biology, are derived from basic principles carefully taking into account the randomness in the processes. In particular, stochastic delay differential equation models are derived and studied for glucose/insulin levels, bacteriophage/bacteria dynamics, and logistic population growth with delay. Numerical methods for approximating the delay SDE models are described. Comparisons between computational solutions of the delay SDEs and independently formulated Monte Carlo calculations support the accuracy of the derivations and of the numerical methods. (Received January 13, 2012)

1079-92-140 **Isabel K. Darcy*** (idadcymath@gmail.com), **Hyeyoung Moon, Rob Scharein, Guanyu Wang** and **Danielle Washburn.** *DNA knot distances.* Preliminary report.

Topoisomerases and recombinases are two classes of proteins which can knot circular DNA. Type II topoisomerases are proteins which cut one double-stranded DNA segment, allowing a second DNA segment to pass

through before resealing the break. This is mathematically modeled by changing a crossing. Recombinases break two segments of DNA, exchanging the DNA ends before resealing the breaks. This action can be mathematically modeled by smoothing a crossing. Distances between knots have been defined based upon the minimum number of times these proteins must act to convert one knot into another knot. Methods for calculating these distances will be discussed. Applications and ways to visualize these distances via KnotPlot will also be discussed. (Received January 18, 2012)

1079-92-162 **Igor M Rouzine*** (igor.rouzine@gladstone.ucsf.edu), 1850 Owens St, San Francisco, CA 94158. *Traveling wave of asexual evolution: no longer solitary.*

Modern evolution theory is focussed on interference (linkage) of adaptive mutations emerging at different DNA locations. Interference effects emerge even in the absence of biochemical interaction of proteins at different sites (co-selection, epistasis, complex fitness landscape) and are a simple consequence of competition of emerging lineages for space in population. Mathematical description of these effect proved to be rather challenging. The effect of interference is strong in populations where recombination between genomes, e.g., due to sexual reproduction, is rare or absent. The examples include bacteria, viruses, yeast, Y chromosomes, mitochondrial DNA, as well any genomic segments in any organisms where evolving sites are closely located and not split by recombination. I will compare two historical approaches, one considering pairs of mutations with different benefit to organism fitness, and another considering multiple mutations with similar fitness effect but different in numbers among genomes. (Received January 10, 2012)

1079-92-191 **Mark Daley*** (daley@csd.uwo.ca). *This is your brain on graphs.*

Functional magnetic resonance imaging (fMRI) allows for the direct visualization of cerebral bloodflow, which has been demonstrated to map very strongly on to neural activity. Neuroscientists have recently begun employing network-theoretic tools to discover patterns of functional and structural connectivity within the brain.

In this talk we will outline the challenges faced, and progress made, in developing the theory, and techniques, required to analyze large-scale brain graphs with tens of thousands of nodes and potentially hundreds of millions of edges as well as discuss the neuroscientific insights gained by the use of these tools. A chief concern at the outset is how to reasonably chose a threshold value to determine which edges should be included in a graph; we will demonstrate an approach to this problem based on the theory of random matrices. We will also include a discussion of graph size reduction, using the technique of metrically-constrained graph minors and a comparison of various graph metrics on real data.

Finally, we will discuss preliminary research in which we borrow from the theory of graph transformations to investigate the dynamics of neural functional connectivity. (Received January 12, 2012)

1079-92-234 **Hendrik Jan Hoogeboom*** (hoogeboom@liacs.nl). *The Algebra of Ciliates.*

Ciliates, an ancient group of unicellular organisms, transform genes from their micronuclear (storage) form into their macronuclear (expressible) form. This process is called gene assembly. The DNA processing involved is interesting from both the biological and the computational point of view.

There are various equivalent ways to formally model gene assembly (at the level of genes). Two of these were extensively studied in the book *Computation in living cells: gene assembly in ciliates* by Ehrenfeucht, Harju et al (Springer, 2004). However, one additional viewpoint is particularly enlightening: the process may be seen as (partial) matrix inversion. We show that on the one hand this leads to a number of significant consequences for the model and on the other hand it enriches general theory.

Joint work with Robert Brijder, Hasselt University, Belgium.

R. Brijder, H.J. Hoogeboom. The Group Structure of Pivot and Loop Complementation on Graphs and Set Systems. *Eur.J.Comb.* (2011). (Received January 15, 2012)

1079-92-248 **Paolo Cermelli*** (paolo.cermelli@unito.it), Dipartimento di Matematica, Universita' di Torino, 10123 Torino, Italy. *Applications of the theory of crystallographic phase transitions to conformational changes in viral capsids.*

We present a method for investigating structural transitions in capsids of icosahedral viruses. Concepts from the theory of three-dimensional (3D) quasicrystals, and from the theory of structural phase transformations in 3D crystalline solids, are combined to give a framework for the study of these structural transformations. Applications to some viruses will be discussed, and case-studies of transitions in quasicrystals, and the related quasiperiodic tilings, will also be presented, in view of a finer descriptions of the transition mechanisms in viruses. (Received January 17, 2012)

- 1079-92-250 **Paola Bonizzoni*** (bonizzoni@disco.unimib.it), Viale Sarca 336, 20126 Milan, Italy.
The binary perfect phylogeny model with persistent characters: applying the parsimony principle to discover genetic variations in individuals.

The perfect phylogeny derives from a restriction of the parsimony methods used to reconstruct the evolution of the species (taxa). The model has several applications in computational biology. In particular, the binary perfect phylogeny has been used in mathematical formulations for the general problem of discovering the most common genetic variations in individuals. A central goal in the investigation of this model is to extend its applicability by taking into account the biological complexity of data and computational efficiency. The binary perfect phylogeny model is too restrictive to model common biological events such as recurrent and back mutations. In the talk we consider a natural generalization of the model that allows a special type of back mutation. We investigate the problem of reconstructing a near perfect phylogeny over a binary set of characters where characters are persistent: during evolution characters can be gained and lost once at the most. Based on this notion, we define the problem of the Persistent Perfect Phylogeny (referred as P-PPH). We restate the P-PPH problem as a special case of the Incomplete Perfect Phylogeny. Then by using a graph formulation of this last version, algorithmic solutions of the P-PPH problem are explored. (Received January 16, 2012)

- 1079-92-284 **Ileana Streinu*** (istreinu@smith.edu), Computer Science Department, Smith College, Northampton, MA 01063. *Periodic rigidity of protein crystal structures.*

Recently, we initiated in silico rigidity-theoretical studies of protein crystal structures, with the goal to determine if, and how, the interactions among neighboring crystal cells affect the flexibility of the biological unit.

In this talk, I will discuss two recent directions, one mathematical and one biological, in which this research is proceeding. The mathematical theory of periodic rigidity, recently introduced by Borcea and Streinu [Proc. Royal Society A, 2010 and Bull. London Math. Soc. 2011] is directly applicable to such investigations. It provides both rigorous treatment and substantial algorithmic advantages over previous approaches. It also leads to further challenging mathematical questions, some of which will be briefly discussed. On the biological side, I will report on some recent work done with students Pamela Clark, Jessica Grant, Samantha Monastra and Filip Jagodzinski. Preliminary results, obtained using the rigidity analysis tools available through the KINARI-Web server <http://kinari.cs.umass.edu> developed in our group, indicate that important information, correlating rigidity parameters with protein function and overlooked until now, may be captured with this kind of analysis. (Received January 16, 2012)

- 1079-92-325 **Egor Dolzhenko***, edolzhen@mail.usf.edu, and **Natasha Jonoska** and **Masahico Saito**.
Polynomial Invariant of Graphs Modeling Nucleotide Rearrangements.

Spatial graphs with 4-valent rigid vertices, also called assembly graphs, describe homologous DNA rearrangements. The possible products of these rearrangements correspond to so called “polygonal paths” in these graphs (paths that take 90-degree “turns” at every vertex). The paths are extracted from the graph by smoothing the vertices, i.e. an operation of removing the vertices and reconnecting the resulting pairs of free neighboring edges. Through smoothings we have developed a polynomial invariant of the assembly graphs capable of distinguishing between different types of rearrangement. These polynomials are motivated by Tutte polynomials and have a number of interesting properties. We will discuss these properties and emphasize the connection between the polynomials and circle graphs. In addition, we will mention how these polynomials can be used to study rearrangements in other biological contexts. (Received January 17, 2012)

- 1079-92-369 **Thomas Keef*** (thomas.keef@york.ac.uk), YCCSA, Ron Cooke Hub, University of York, York, YO10 5GE, England. *Boundary Conditions on Protein Structures in Assemblies with Non-Crystallographic Symmetries.*

Non-crystallographic symmetry has long been recognised as important for the structures of assemblies of proteins. It has been shown that point sets generated by affine extensions of non-crystallographic symmetry groups can be fitted to the external shapes of protein clusters with the same symmetry. Using a projection from the appropriate higher dimensional crystallographic lattice we will show that there are Penrose tilings which include the point sets previously calculated. These tilings are finer-graded than the calculated point sets, and in addition have information on edges between vertices providing an bounding boxes for the individual proteins within a cluster based on these Penrose tilings. This is the first time that Penrose tilings have been used to provide information on the shape and structure of individual proteins within a cluster and show that the symmetry of the entire protein assembly and the structure of the individual proteins within it are intimately linked. (Received January 18, 2012)

1079-92-377 **Alberto Castellini** and **Giuditta Franco*** (giuditta.franco@univr.it), Via Zannoni 16, I-37136 Verona, Italy, and **Vincenzo Manca**. *String problems inspired by genome analysis*.

A methodology based on dictionaries is presented, where k-mer distributions are integrated by specific informational indexes, inspired by biological knowledge on functional organization of genome structure.

Let $D_k(G)$ be the dictionary of all k-factors in a genome G . For any length k , other genomic dictionaries may be defined on the basis of k-word *multiplicity* (number of occurrences). Let *forbidden dictionary* $F_k(G)$ collect k-words which do not occur in genome G , *hapax dictionary* $H_k(G)$ collect k-words occurring once, and *repeat dictionary* $R_k(G)$ collect k-words occurring more than once. Of course $(H_k(G), R_k(G))$ is a bipartition of $D_k(G)$.

In the talk we report multiplicity distributions, and cardinality (relative) variation of such dictionaries (with respect to k), as computed for ten specific genomes. We discuss results from previous work, where hapax/repeat cardinality ratio, minimal forbidden and maximal repeat length were defined, and specific genomic features were investigated by means of them. Indeed, a sort of transition phase was empirically discovered in distributions of repeats having a length between 12 and 18.

Some open string problems, which appear of interest in our genome analysis, conclude the talk. (Received January 18, 2012)

1079-92-393 **Angela Angeleska***, aangeleska@ut.edu, and **Sabrina Kleessen** and **Zoran Nikoloski**. *Integer Quadratic Programming and the Sequence Reconstruction Problem*.

Assembly of genomes from high-throughput data generated by the Next Generation Sequencing (NGS) technologies remains one of the most challenging tasks in modern biology. Here we address the Sequence Reconstruction (SR) problem whereby, for a given collection of subsequences or factors, one is to determine the set of sequences compliant with the collection. First, we give an overview of the SR problem from a language-theoretic perspective, and present the advantages and shortcomings of the existing algorithmic approaches. We then propose an optimization-based formulation which casts the problem as an integer quadratic program whose solutions can be enumerated with appropriate transformations. Finally, we consider three different variants of the SR problem with respect to the input: (1) subset of factors, (2) subset of paired factors, and (3) subset of factors and their inverses. Each of these variants is relevant for the genome assembly problem and can be matched with the employed NGS technologies. The modification of the constraints imposed in the formulation of the respective programs and the different means for their relaxation are also discussed. (Received January 18, 2012)

1079-92-416 **Christine E Heitsch***, Georgia Institute of Technology, School of Mathematics, Atlanta, GA 30332. *“RNA folding prediction: the continued need for interaction between biologists and mathematicians”*.

A 1986 article by M. Zuker with this title, published in an AMS collection, outlined several major questions in the area — many of which are still relevant today. Stating the folding problem is simple; given an RNA sequence, predict the set of (canonical, nested) base pairs found in the native structure. Yet, despite significant advances over the past 25 years, it remains largely unsolved. A fundamental challenge identified by Zuker was, and still is, the “ill-conditioning” of discrete optimization solution approaches. We revisit some of the questions this raises, and present recent advances in considering multiple (sub)optimal structures, in incorporating auxiliary experimental data into the optimization, and in characterizing sequences for which the optimization does give satisfactory results. (Received January 18, 2012)

1079-92-426 **Erez Lieberman Aiden*** (erez@math.harvard.edu), Laboratory-at-Large, 307A Pierce Hall, Cambridge, MA 02138. *How the genome folds*.

I describe Hi-C, a novel technology for probing the three-dimensional architecture of whole genomes. Developed together with collaborators at the Broad Institute and UMass Medical School, Hi-C couples proximity-dependent DNA ligation and massively parallel sequencing.

Our lab employs Hi-C to construct spatial proximity maps of the human genome. Using Hi-C, it is possible to confirm the presence of chromosome territories and the spatial proximity of small, gene-rich chromosomes. Hi-C maps also reveal an additional level of genome organization that is characterized by the spatial segregation of open and closed chromatin to form two genome-wide compartments. At the megabase scale, the conformation of chromatin is consistent with a fractal globule, a knot-free conformation that enables maximally dense packing while preserving the ability to easily fold and unfold any genomic locus. The fractal globule is distinct from the more commonly used globular equilibrium model. Our results demonstrate the power of Hi-C to map the dynamic conformations of whole genomes. (Received January 18, 2012)

1079-92-443 **Jemal Mohammed-Awel***, jmohammedawel@valdosta.edu. *Modeling screened-refuge technique in agricultural pest control using semi-discrete modeling*. Preliminary report.

Genetically engineered crop plants that produce insecticidal toxins from the bacterium *Bacillus thuringiensis* (Bt) which are toxic to a variety of common agricultural pests were introduced in 1996 and have seen significant and increasing adoption in the intervening for 15 years. A gene from the bacterium *Bacillus thuringiensis* (Bt) has been inserted into the DNA of several crop varieties. This gene codes for the production of a protein highly toxic to many insect pests. However, extensive use of Bt crops entails the risk of promoting development of pest resistance to Bt toxin. The study considers a 'Screened-refuge' technique for sustaining control of insect pests using Bt crops. A model based on semi-discrete/impulsive differential equations is proposed to address the evolution of pest resistance. The mathematical study provide conditions under which a unique globally asymptotically stable equilibrium exists. The conditions are expressed in terms of key model parameters that should help to understand the evolution of pest resistance to Bt crops. (Received January 19, 2012)

93 ► *Systems theory; control*

1079-93-66 **N U AHMED*** (ahmed@site.uottawa.ca), 800 King Edward Str, University of Ottawa, Ottawa, Ontario K1N6N5, Canada. *INFINITE DIMENSIONAL STOCHASTIC SYSTEMS AND OPTIMAL CONTROL OF INDUCED MEASURES BY FEEDBACK OPERATORS WITH STRONG OPERATOR TOPOLOGY*.

In this paper we consider direct optimal feedback control of stochastic differential equations on infinite dimensional spaces. The system is governed by a semilinear evolution equation. The principal operator, generating a C_0 -semigroup, is perturbed by a class of bounded linear operators from an admissible set in the space of bounded linear operators endowed with the strong operator topology. These are considered as state or output feedback controls. We consider the corresponding family of measure valued functions and present sufficient conditions for weak compactness on the space of probability measures and functions taking values in these spaces. Our interest is to control the temporal evolution of these probability measure valued functions by use of feedback operators so as to extremize certain objective functionals defined on the space of measures. We present results on existence of optimal feedback operators.

Key Words Stochastic Differential Equations, Banach Spaces, Optimal Feedback Control, Objective Functionals, Lévy-Prohorov metric, Hausdorff dimension, Time-Optimal problems.

2000 AMS Subject Classification 49J27, 60H15, 93E20 (Received December 15, 2011)

1079-93-292 **N. Jordan Jameson*** (njordan.jameson@gmail.com), 6408 Frisco Avenue, Nashville, TN 37209, and **M. Knap, S. Sathananthan** and **L.H. Keel**. *Impulsive State Feedback Control of Markovian Switching Linear Stochastic Systems*.

Motivated by Markovian Switching Rational Expectation Models (MSRE) in economics, a problem of state feedback stabilization of discrete-time linear Markovian switching stochastic systems with multiplicative noise is considered. Under some appropriate assumptions, the stability of this system under pure impulsive control is given. Further under impulsive control, the state feedback stabilization problem is investigated. The Markovian switching is modeled by a discrete-time Markov chain. The control input is simultaneously applied to both the rate vector and the diffusion term. Sufficient conditions based on linear matrix inequalities (LMIs) for stochastic stability is obtained. The robustness of the LMI-based stability and stabilization concepts against all admissible uncertainties are also investigated. The parameter uncertainties we consider here are norm bounded. An example is given to demonstrate the obtained results. (Received January 17, 2012)

1079-93-373 **Karin Valencia*** (karin.valencia06@imperial.ac.uk), Imperial College London, South Kensington Campus, Huxley Building, Room 640, London, SW7 2AZ, England, and **D Buck, N Jonoska** and **M Saito**. *Genome-wide rearrangements in ciliates: the genus of assembly graphs*.

Ciliated protozoa are unicellular organisms that contain two types of specialized nuclei, with functionally distinct copies of the genome: a germline *micronucleus* (MIC) consisting of genes crippled by the presence of short non-coding sequences, and a somatic *macronucleus* (MAC) consisting of gene-size DNA segments made up of subunits of the MIC genes, arranged in very precise ways. During conjugation, new MIC DNA is highly edited, via recombination and other not well understood processes, and is converted into new MAC DNA. Experimental evidence suggest many recombination events can happen simultaneously. This process was previously modelled using spatial graphs, called *assembly graphs*, which consist of 1-valent and 4-valent rigid vertices, by Angeleska,

Jonoska and Saito. In this talk, we investigate the topological complexity of assembly graphs by considering the highest bound of the orientable cellular genus as a function of the number vertices n . We show that a special type of assembly graph, the *tangled cord* Γ_n , maximises the genus overall assembly graphs and we find its genus range.

$$\frac{n-2}{2} \leq \gamma(\Gamma_n) \leq n \text{ if } n \text{ is even}$$

$$\frac{n-1}{2} \leq \gamma(\Gamma_n) \leq n \text{ if } n \text{ is odd}$$

(Received January 18, 2012)

94 ► *Information and communication, circuits*

1079-94-167

Claude Carlet, LAGA, Universities of Paris 8 and Paris 13;, CNRS, UMR 7539, University of Paris 8, Department of Mathematics, Paris, France, **Philippe Gaborit**, XLIM-DMI, Universite de Limoges, Limoges, France, **Jon-Lark Kim*** (jl.kim@louisville.edu), 328 Natural Sciences Building, Department of Mathematics, Louisville, KY 40292, and **Patrick Sole**, CNRS/LTCI, UMR 5141, Telecom ParisTech, Paris, France. *A new class of codes for Boolean masking of cryptographic computations.*

We introduce a new class of rate one half binary codes: **complementary information set codes**. A binary linear code of length $2n$ and dimension n is called a complementary information set code (CIS code for short) if it has two disjoint information sets. This class of codes contains self-dual codes as a subclass. It is connected to graph correlation immune Boolean functions of use in the security of hardware implementations of cryptographic primitives. Such codes permit to improve the cost of masking cryptographic algorithms against side channel attacks. In this paper we investigate this new class of codes: we give optimal or best known CIS codes of length < 132 . We derive general constructions based on cyclic codes and on double circulant codes. We derive a Varshamov-Gilbert bound for long CIS codes, and show that they can all be classified in small lengths ≤ 12 by the building up construction. (Received January 11, 2012)

1079-94-173

Jon-Lark Kim, Department of Mathematics, University of Louisville, Louisville, KY 40292, and **Xiaoyu Liu*** (xiaoyu.liu@wright.edu), Department of Mathematics and statistics, Wright State University, Dayton, OH 45435. *A Generalized Gleason-Pierce-Ward Theorem.*

The Gleason-Pierce-Ward theorem gives constraints on the divisor and field size of a linear divisible code over a finite field whose dimension is half of the code length. This result is a departure point for the study of self-dual codes. In recent years, additive codes have been studied intensively because of their use in additive quantum codes. In this work, we generalize the Gleason-Pierce-Ward theorem on linear codes over $GF(q)$, $q = p^m$, to additive codes over $GF(q)$. The first step of our proof is an application of a generalized upper bound on the dimension of a divisible code determined by its weight spectrum. The bound is proved by Ward for linear codes over $GF(q)$, and is generalized by Liu to any code as long as the MacWilliams identities are satisfied. The trace map and an analogous homomorphism $x \mapsto x - x^p$ on $GF(q)$ are used to complete our proof. (Received January 11, 2012)

WASHINGTON, DC, March 17–18, 2012

Abstracts of the 1080th Meeting.

00 ► General

1080-00-4 **Jim Geelen***, Department of Combinatorics and Optimization, University of Waterloo, 200 University Avenue West, Waterloo, Ontario N2L 3G1. *Matroid minors*.

This talk is intended to be a gentle introduction to matroid theory, with a bias towards questions involving matrices over finite fields. In particular, we are interested in structural properties of matroids in minor-closed classes; you are not expected to know what that sentence means before the talk.

The new results in the talk are joint work with Bert Gerards and Geoff Whittle. (Received April 26, 2011)

1080-00-5 **Abdol'azim - Karimi*** (karimi@rie.ir), No 68 , Mozaffar St., Enghelab Ave., Tehran, iran, 141693567 Tehran, Iran. *a comparison of high and low schools performance in the TIMSS (The Trends in International Mathematics and Science Study)*.

The purpose of this study is to identify the distinguishing factors among schools and their impact on Iranian students' performance. These factors could be applied to separate schools into high or low-performance schools. Study is done based on obtained data from "student's and teacher's questionnaire" filled out by participating schools in international studies PIRLS2006. Participated schools were separated into two groups of high performance or low performance schools based on (+,-) 1.5 standard deviations from whole class mean. Factors to be investigated were school performance related features such as School Environment, Human resource, Facilities and Equipments, Teachers' age and backgrounds, Schools' Instructional time per week, Density and Number of students in each class, In-use Resources in school. Utilizing Logistic Regression pointed out the following variables as distinguishing factors for different subject of study at different levels: • Reading literacy for both grade 4

- Teacher's age and school environment for grade 4
- Number of students in class and Teacher's age for grade 4
- School environment for grade 8 mathematics

Key words: PIRLS2006, , mathematics , High and low performance schools (Received September 10, 2011)

1080-00-191 **Evelyn Kamaria Thomas*** (evelyn.k.thomas@gmail.com). *The Effect of Male Bisexuality on the Spread of Incurable Sexually Transmitted Diseases*.

The goal of this research is to determine the role bisexuality, among males, plays on the spread of incurable sexually transmitted diseases within a heterosexual female population. A system of eight ordinary differential equations was constructed to describe these dynamics. In order to fully understand the dynamics within this system, the model was deconstructed into smaller systems of ordinary differential equations, which represent segments of the interacting populations. Such information will assist in making predictions as to whether the disease will stabilize, increase, or decrease. (Received January 26, 2012)

1080-00-195 **Saliha Pehlivan*** (saliha@knights.ucf.edu). *Optimal Dual Frames with respect to Spectral Radius Measure*.

Frames have been useful in signal transmission due to the built in redundancy. In recent years, the erasure problem in data transmission has been the focus of considerable research dealing with norm measure, and some characterizations of optimal frames and optimal dual frames for erasures with respect to norm measure. Since spectral radius as a measure is competitive and better in certain situations, the main aim is to examine dual frames which are optimal with respect to spectral radius measure. Some results on 1-optimal erasure and 2 optimal erasures will be given. (Received January 26, 2012)

1080-00-332 **James L. Carroll*** (j1carroll@lanl.gov) and **Chris Tomkins** (ctomkins@lanl.gov). *Physics-Based Constraints in the Forward Modeling Analysis of Time-Correlated Image Data*.

Scientific applications of image-based measurement typically require rigorous analysis of quantitative image data. The forward-model approach with optimization has been shown to produce accurate reconstructions of scientific measurements for single-time image data. Here we apply simple physics-based constraints to the forward model analysis of a series of images that are correlated in time. The constraints are implemented through a representational bias in the model and, owing to the smooth nature of the physics evolution in the specified

model, also provide an effective temporal regularization. Unlike more general temporal regularization techniques, the application of physics restricts the space of solutions to those that are physically realizable. We explore the performance of this approach on a simple radiographic imaging problem of a simulated object evolving in time. We demonstrate that the constrained simultaneous analysis of the image sequence outperforms the independent forward modeling analysis over a range of degrees of freedom in the physics constraints, including when the physics model is under-constrained. Further, this approach outperforms the independent analysis over a large range of signal-to-noise levels. (Received January 31, 2012)

1080-00-338 **Svetlana V. Poroseva*** (poroseva@unm.edu), Albuquerque, NM 87131-0001. *Probabilistic approach to evaluating the topological survivability of networks with heterogeneous nodes.*

Many engineering networks such as, for example, electric power, gas, water, and transportation systems fall into the category of networks with heterogeneous nodes. For such a network, the ability to withstand multiple simultaneous faults in nodes and links (survivability) is vital. A key factor in the network survivability is its topology, that is, how network elements are connected with one another. Probabilistic approach to evaluate the network survivability that is due to its topology will be presented. (Received January 31, 2012)

01 ► *History and biography*

1080-01-28 **Kristina M Leifeste*** (kleifest@nmsu.edu). *A Preacher, a Rabbi, and Old Measuring Tools: A Look at the Use of the Diagonal Scale and Gunter's Chain in English Geometry Texts from 1746 to 1984.*

The diagonal scale, whose origins are credited to Rabbi Levi Ben Gershon (1288-1344), is a 2-dimensional scale, drawn on a flat surface, used to measure short lengths up to a precision of three figures, much as we use a caliper today. Gunter's Chain, invented by English clergyman Edmund Gunter (1581-1626), was a 22-yard long metal chain used for surveying large areas of land. While the diagonal scale is still seen today in architecture and drafting books, Gunter's Chain is no longer used. However, both tools were presented in early practical geometry texts. This talk will cover the history and descriptions of both tools, their uses, and their prevalence in English and American geometry texts beginning from (at least) 1746 (Stewart) through 1984 (Earle). Using these texts, we are able to chronicle the appearance of these instruments, presented both separately and together, and to show how they were used to solve geometry problems in practical ways. (Received November 29, 2011)

1080-01-30 **Peggy Aldrich Kidwell*** (kidwellp@si.edu), MRC671, NMAH, Smithsonian Institution, P.O. Box 37012, Washington, DC 20013-7012. *The Fifteen Puzzle and American Mathematical Recreations.* Preliminary report.

The Fifteen Puzzle was the first mathematical recreation devised in the United States to sweep the world. It attracted the attention of mathematicians and mathematical physicists in the US, the UK, and Europe. Sold commercially in Boston from late 1879, it crossed the country the following spring, and the world soon thereafter. The puzzle consists of 15 tiles (or, in some early versions, cubes), numbered from 1 to 15 and arranged in a 4x4 grid, with a single blank space. The goal is to slide the tiles without lifting them so that they are arranged in numerical order, with the space at the end. The story of the Fifteen Puzzle aptly illustrates of the rise of American invention and manufacture of puzzles. Its rapid diffusion and study reflects the growing role of American institutions for communicating new ideas, both for the population generally and for scholars. Contemporary analysis of the puzzle reflects the growing participation of Americans in an international community of mathematicians. Moreover, like other recreations, the Fifteen Puzzle challenged emerging boundaries between research mathematicians and mathematics educators. (Received December 05, 2011)

1080-01-32 **Amy Ackerberg-Hastings*** (aackerbe@verizon.net), 5908 Halsey Road, Rockville, MD 20851. *Teaching Mathematics with Objects: The Case of Protractors.* Preliminary report.

In the twentieth century, American primary and middle schools almost universally adopted protractors for teaching angle measurement and introducing the concepts of geometry. However, it was not obvious that this drawing instrument, which had been employed in professional practice for several centuries, would become ubiquitous in educational contexts. The story of the protractor's journey into schools in fact illustrates a number of the themes that emerge from the historic use of objects in mathematics teaching: 1. The passionate rhetoric of advocates for objects. 2. Grand schemes for reform movements whose lasting influence is ultimately limited and particular. 3. Correlations between objects and the development of educational standards. 4. Expansions in student populations that stimulate reconsiderations of the reasons for teaching mathematics. The talk is based upon lessons learned from the preparation of *Tools of American Mathematics Teaching, 1800-2000*, as well as a

recent effort to re-catalogue the protractors held in the mathematics collections of the Smithsonian Institution. (Received December 05, 2011)

1080-01-68 **Chris Rorres*** (rorres@vet.upenn.edu). *Archimedes, Floating Cylinders, and the “Old Man of the Lake”*. Preliminary report.

In the second of his two seminal works on floating bodies, Archimedes investigated how paraboloids float. This work included the first formulation of the conditions for a floating body to be in equilibrium and the conditions for an equilibrium position to be stable rather than unstable. In a previous paper I extended Archimedes’ work on floating paraboloids and in this talk I will discuss analogous results for floating cylinders. One particular application that I’ll present is how a horizontally floating log can transition to a vertically floating log—a “deadhead” in logger terminology. An example of this is the *Old Man of the Lake*, a celebrated deadhead that has been floating in Oregon’s Crater Lake for more than a century. (Received January 06, 2012)

1080-01-76 **Ubiratan D’Ambrosio*** (ubi@usp.br), Rua Peixoto Gomide, 1772 ap.83, São Paulo SP, 01409-002, Brazil. *Mathematical relations between the USA and Brazil in the Early Post World War II Era*.

The paper briefly describes the development of mathematics research in Brazil, under the influence of Portugal and France, and the Italian influence preceding World War II. After the end of World War II a brief presence of French mathematicians preceded an intensification of the relations with the USA. The main focus of the paper is the development of these relations. There is a brief exposition of the activities of the Rockefeller Foundation, of the John Simon Guggenheim Memorial Foundation and of the Fulbright Scholarship Program in support of Mathematics scholarship in Brazil. Special attention will be given to the creation of the I.T.A. (Aeronautical Technology Institute), in 1950, and the influence of the M.I.T. There is also a report on the creation of the CNPq (National Research Council) and of its Mathematical Institute, the IMPA, in 1957. The main focus of the paper is the influence of American mathematicians, specially A. Adrian Albert (1948) and Marshall H. Stone (1949), in the development of Mathematics in Brazil. (Received January 10, 2012)

1080-01-77 **Betty Mayfield*** (mayfield@hood.edu), Department of Mathematics, Hood College, 401 Rosemont Avenue, Frederick, MD 21701. *Phillip S. Jones: Mathematician, Historian, Educator*. Preliminary report.

Phillip S. Jones (1912-2002), a mathematician at the University of Michigan, was dedicated to the history and pedagogy of mathematics. He was a leader in both the National Council of Teachers of Mathematics and the Mathematical Association of America, publishing in their books and journals and participating in their governance. This talk will describe his work in history, in pedagogy, and especially in the relationship between the two. (Received January 10, 2012)

1080-01-104 **Victor J Katz*** (vkatz@udc.edu). *Algebra in Words vs. Algebra in Symbols*. Preliminary report.

Some historians insist that a definition of “algebra” must involve the inclusion of symbolism. Under this definition algebra would not exist before the seventeenth century. On the other hand, the classic definition of algebra, given by Euler, among others, is “the science which teaches how to determine unknown quantities by means of those that are known.” Under this definition, Islamic mathematicians from the time of al-Khwārizmī were certainly doing “algebra,” even though all of their procedures were written out entirely in words. But writing everything in words causes problems, particularly when one is solving intricate problems. We will take a look at the difficulties Islamic and medieval European mathematicians had when writing out solutions in words and why, at some point, it became virtually impossible to proceed further. Implications for the teaching of algebra will be considered. (Received January 16, 2012)

1080-01-129 **Bruce J. Petrie*** (b.petrie@utoronto.ca). *Paradigms, Mathematics, and Education*. Preliminary report.

Thomas Kuhn’s paradigm concept has not only been considered notoriously vague but the applicability of Kuhn’s structure of scientific revolutions to mathematics has been heavily criticized in the literature. Regardless, his paradigm concept remains fruitful for historians and mathematicians engaged in history of mathematics. The concept of paradigm also proves useful for the education of mathematics. I will show in this special session on The Relations Between the History and Pedagogy of Mathematics that the paradigm concept can transform traditional mathematics education. (Received January 20, 2012)

1080-01-141 **Maryam Vulis*** (maryam@vulis.net), 67-67 Burns St, Apr 4K, Forest Hills, NY 11375.
Remarkable Russian Elementary Mathematics Textbooks. Preliminary report.

Starting in 1884, many generations of students benefited from the textbooks written by the mathematics teacher A.P. Kiselev. A.P. Kiselev authored textbooks on arithmetic, elementary algebra, elementary geometry, beginning analysis, and physics. The clarity and logic of his textbooks were of great aid to students for almost a century and continue bringing nostalgia to many mathematics teachers.

(Received January 21, 2012)

1080-01-189 **Florence Fasanelli*** (ffasanel@aaas.org), AAAS, 1200 New York Ave., Washington, DC 20005. *Andrew Ellicott: mathematician, surveyor, teacher*.

Since ancient times, conquerors have sent mathematicians to survey their new territory. Andrew Ellicott (1754-1820) had a profound impact on the shape of this country, establishing boundaries of states and cities as well as its international boundaries both north and south. In 1791, he surveyed the territory now known as the District of Columbia and a year later produced the first engraved map of the future city developed from plans of Pierre L'Enfant. In 1796, he surveyed the international border between the U.S. and Spanish territories in Florida under the San Lorenzo Treaty. In 1817, he was appointed astronomer for the United States establishing the boundary between the US and Canada, concluding the War of 1812.

As a teacher his most famous student was Meriwether Lewis who needed field instruction before Lewis' great expedition to the west. In 1813, he was appointed by President Monroe as a professor of mathematics at the Military Academy at West Point where he was among the first in the country who taught a class in calculus. (Received January 26, 2012)

1080-01-197 **V. Frederick Rickey*** (fred.rickey@me.com), Department of Mathematical Statistics, USMA, West Point, NY 10996, and **Theodore J. Crackel**. *The Education of George Washington*. Preliminary report.

At a meeting at George Washington University, what could be more fitting than talking about George Washington. It is unclear how much education he received: among the possibilities are an ABC school operated by one of his father's tenants, some tutoring by a transported convict, and few years in a school operated by the Reverend James Marye in Fredricksburg, but the details in each case are sketchy. In addition, after his father died in 1743, his mother sent him to live with his half-brother Austin who had very recently been an assistant teacher at Appleby Grammar School in the north of England. Fortunately, from these early teenage years, 13 to 15, two copybooks survive and from them we know what he learned of algebra, trigonometry, surveying, and other subjects. The copybooks will be discussed in detail. (Received January 31, 2012)

1080-01-303 **Walter Meyer*** (meyer1@adelphi.edu), Department of Mathematics & Computer Science, Adelphi University, Garden City, NY 11530. *Curricular Change in American Undergraduate Mathematics from 1950 to 2000*.

We will give a short review of the major curricular changes and proposals for change of the second half of the 20th century with a view to sketching the impersonal forces behind these changes. Is there a tidy theory of such forces in this era? Do the changes merely reflect the evolving state of mathematics in a cut-and-dried way? Could it all be explained as a reaction to Modernism (in the sense of J. Gray)? The latter hypothesis might be true, while still not explaining much. It appears that external circumstances played a role in curricular changes.

We offer the challenge of considering analogous questions for curricula in the first half of the 20th century. (Received January 30, 2012)

1080-01-317 **Young Hee Kye*** (yhkye@kosin.ac.kr), #149-1 Dongsan-dong Yeongdo-gu, Busan, 606-080, South Korea. *Abstraction of Math and Art of the Orient and West*.

In 19th century, European society had pursued the idea of autonomy. At that time, Cantor invented set theory, which had abstracted for all fields of math. Also, woman painter S. Valadon painted her own self-portrait in nude. I think that these phenomena are results from the idea of autonomy. The appearance of pointillism artist Seurat and Signac is the spirit of the same times with set theory. What is the characteristic of contemporary art? I think that one is destruction of perspective drawing, the other is simplification as topology. Actually, in 1940, modern artist Matisse painted a woman in nude, which is really simple. In the Orient, we can see the unique Japanese drawing that was drawn in 8th middle century. This drawing has been called Kampil-Bub. It means simple drawing without detail expression and description. For example, Mapo-bosalsang is drawn bodhisattva on the hemp. Also, prominent Chinese painter Yang Hae drawn Li Bai by Kampil-Bub: He was a poet of Tang dynasty. How we should explain these description? Hence I assert that the valuation of history and culture have to be different. It is not the Western paradigm but pan-paradigm. (Received January 31, 2012)

1080-01-339 **David Lindsay Roberts*** (robertsdl@aol.com). *American Mathematicians as Educators: A Historical Survey of Jurisdictional Conundrums*. Preliminary report.

American research-trained mathematicians, including some of the most prominent investigators in the field, have been sporadically involved with school instruction from the late nineteenth century to the present. What has motivated this activity, and how have such mathematicians attempted to deploy their influence? How have their efforts been perceived by their mathematician colleagues and by other educators? Is a mathematics Ph.D. a general license to pronounce on education? I will describe some notable episodes of educational activism by mathematicians over more than 100 years, and will comment on evolving attitudes, environments, and outcomes. (Received January 31, 2012)

03 ► *Mathematical logic and foundations*

1080-03-164 **Alberto Marcone** (alberto.marcone@dimi.uniud.it), Dipartimento di Matematica e Informatica, 33100 Udine, Italy, **Antonio Montalbán** (antonio@math.uchicago.edu), Department of Mathematics, University of Chicago, Chicago, IL 60637, and **Richard A Shore*** (shore@math.cornell.edu), Department of Mathematics, Cornell University, Ithaca, NY 14853. *Computing maximal chains in wpos*.

We consider a few theorems about well partial orders (no infinite descending chains or antichains) from a computational point of view and contrast that analysis with one from the viewpoint of reverse mathematics. In the second setting all the theorems we consider are equivalent to ATR_0 . In terms of recursion theoretic or computational complexity as measured by the Turing degrees, however, there are several different situations. In particular, we study the existence of maximal and strongly maximal chains as well as maximal linear extensions. (Received January 24, 2012)

1080-03-173 **Peter Cholak*** (cholak@nd.edu), **Damir Dzhafarov**, **Noah Schweber** and **Richard Shore**. *Computationally enumerable partial orders*.

We study the degree spectra and reverse-mathematical applications of computably enumerable and co-computably enumerable partial orders. We formulate versions of the chain/antichain principle and ascending/descending sequence principle for such orders, and show that the latter is strictly stronger than the former. We then show that every \emptyset' -computable structure (or even just of c.e. degree) has the same degree spectrum as some computably enumerable (co-c.e.) partial order, and hence that there is a c.e. (co-c.e.) partial order with spectrum equal to the set of nonzero degrees. (Received January 25, 2012)

1080-03-177 **Paul Shafer*** (shaferpe@appstate.edu), Department of Mathematical Sciences, Appalachian State University, 121 Bodenheimer Drive, Walker Hall, Boone, NC 28608. *The Medvedev degrees as semantics for propositional logic*.

In 1955 Medvedev introduced the degree structure that bears his name as a formalization of Kolmogorov's ideas for a calculus of problems and a logic of problem solving. Medvedev hoped that his degrees would give semantics for intuitionistic logic, but he instead proved that his degrees give semantics for the logic of weak excluded middle (the logic obtained from intuitionistic logic by adding the axiom scheme $\neg p \vee \neg\neg p$). In 1988 Skvortsova realized a version of Medvedev's hope by proving that there is an initial segment of the Medvedev degrees that gives semantics for intuitionistic logic. In this talk, we discuss some of the recent work addressing the question "For what logics do the initial segments of the Medvedev degrees give semantics?" (Received January 25, 2012)

1080-03-218 **Brooke M Andersen**, **Asher M Kach**, **Alexander G Melnikov** and **Reed Solomon*** (solomon@math.uconn.edu). *Jump degrees of torsion free abelian groups*.

For a countable structure \mathcal{A} , the degree spectrum of \mathcal{A} is the set of Turing degrees which can compute a presentation of \mathcal{A} . For a computable ordinal α , if the set of degrees of the form \mathbf{d}^α , for \mathbf{d} in the degree spectrum of \mathcal{A} , has a least element, then this least degree is the α -th jump degree of \mathcal{A} . Our main result is that for every computable ordinal α and every degree $\mathbf{d} > \mathbf{0}^\alpha$, there is a torsion free abelian group with jump degree \mathbf{d} . (Received January 27, 2012)

1080-03-248 **Ferit Toska*** (toskaf@uf1.edu), P.O. Box 118105, Gainesville, FL 32611, and **Douglas Cenzer**. *Compressibility of Countable Subshifts*.

We investigate the compressibility of subsets of $2^{\mathbb{N}}$ and binary sequences via strict process machines. A complexity notion for binary sequences is introduced. The strict process machine complexity of $x \in 2^{\mathbb{N}}$ is equal to its effective Hausdorff dimension. For any subshift Q of finite Cantor-Bendixson rank and any $c \in \mathbb{N}$

there is a subshift of the same rank that c -compresses Q . On the other hand, if P and Q are subshifts with $rk(Q) < rk(P) < \infty$, then P c -compresses Q for any $c \in \mathbb{N}$. (Received January 29, 2012)

1080-03-278 **Mariya I. Soskova*** (msoskova@fmi.uni-sofia.bg). *Extensions of the Turing model for relative definability.*

The mathematical analysis of the notion of definability is one of the principal objectives of Mathematical Logic. We wish to understand how one object can be used to specify another one. Depending on the mathematical nature of the objects in question and the method for the relative specification one can distinguish between many different approaches. In every case the approach gives rise to a reducibility between the objects, with a natural structural representation as a partial order, its degree structure, a model of relative definability.

The most studied model of relative definability between sets of natural numbers, is that of the Turing degrees based on the notion of Turing reducibility. A project by Ganchev, Soskov and M. Soskova is to examine the standard Turing model in a wider context. Two extensions of the Turing degrees are studied: the structure of the enumeration degrees, based on a weaker form of relative computability between sets of natural numbers; and a further extension, the structure of the omega-enumeration degrees, where the objects are sequences of sets of natural numbers and the reducibility incorporates the notion of uniformity. We will describe this work, comparing results about each structure. (Received January 30, 2012)

1080-03-284 **David Diamondstone** and **Johanna N. Y. Franklin*** (johanna.franklin@uconn.edu), Department of Mathematics, 196 Auditorium Road, University of Connecticut, Unit 3009, Storrs, CT 06269-3009. *Lowness for difference tests.*

We prove that the sets that are low for difference tests are all computable. Since the sets that are low for difference randomness are precisely the K -trivial sets, this proves that lowness for difference randomness and lowness for difference tests do not coincide. This is the first randomness notion for which this is known to be the case. (Received January 30, 2012)

1080-03-291 **Alexandra A. Soskova*** (asoskova@fmi.uni-sofia.bg), Faculty of Mathematics and Informatics, Sofia University, 5 James Bourchier blvd, Sofia, 1164. *Partial Degree Spectra.*

The degree spectrum $DS(\mathfrak{A})$ of a countable structure \mathfrak{A} is the set of all enumeration degrees of all presentations of \mathfrak{A} , and the co-spectrum $CS(\mathfrak{A})$ of \mathfrak{A} is the set of all lower bounds of $DS(\mathfrak{A})$. If a structure \mathfrak{A} has a degree, i.e. a least element of $DS(\mathfrak{A})$, then it is a co-degree, i.e. the greatest element of $CS(\mathfrak{A})$. There are examples of structures with no degree, but with a co-degree.

We will present a generalization of the notion of degree spectrum, considering all partial presentations of a countable structure \mathfrak{A} and we will call it a partial degree spectrum $PS(\mathfrak{A})$. We will prove that in this case if a structure \mathfrak{A} has a co-degree then it has a degree.

We will give some conditions for relative stability of a structure over the natural numbers with respect to the partial presentations.

This is a joint work with Ivan N. Soskov. (Received January 30, 2012)

1080-03-297 **Bernard Anderson** and **Barbara F Csima***, Department of Pure Mathematics, Waterloo, Ontario N2L 3G1, Canada. *Degrees that are not degrees of categoricity.*

E. B. Fokina, I. S. Kalimullin and R. G. Miller introduced the notion of a degree of categoricity to be a Turing degree that exactly measures the complexity of computing isomorphisms between copies of a computable structure. In this talk we give examples of degrees that are not degrees of categoricity. (Received January 30, 2012)

1080-03-301 **Peter Cholak**, **Peter Gerdes** and **Karen Lange***, Mathematics Department, Wellesley College, 106 Central St., Wellesley, MA 02481. *Classifying \mathcal{D} -maximal sets.* Preliminary report.

In 1974, Soare proved that the maximal sets form an orbit in the automorphism group of \mathcal{E} , the set of computably enumerable sets under inclusion. In 1992, Downey and Stob also showed that the *hemimaximal sets*, i.e., splits of maximal sets, form an orbit. Here, we examine the \mathcal{D} -maximal sets, a further generalization of the maximal sets that encompasses the hemimaximal sets as well. Let $\mathcal{D}(A)$ consist of the c.e. sets disjoint from A . A set is then *\mathcal{D} -maximal* if $\mathcal{L}(A)/\mathcal{D}(A)$ is the two element boolean algebra. We develop a classification of the \mathcal{D} -maximal sets and show that they break into infinitely many orbits (Received January 30, 2012)

1080-03-308 **Jesse Johnson, Julia Knight*** (knight.1@nd.edu), **Victor Ocasio, Jamalbek Tussupov** and **Steven VanDenDriessche**. *Categoricity and relative categoricity of structures of familiar kinds*. Preliminary report.

We show that for each computable limit ordinal α , there are computable structures that are Δ_α^0 -categorical but not relatively Δ_α^0 categorical in each of the following classes: undirected graphs, 2-step nilpotent groups, and rings. We also show that for each computable ordinal $\alpha \geq \omega$ (either limit or successor ordinal), there is a computable field (of any desired characteristic) that is Δ_α^0 categorical but not relatively Δ_α^0 categorical. For these results, we take an abstract approach, similar to that of Hirschfeldt, Khoushainov, Slinko, and Shore for transferring results on computable dimension from one class to another, but with more relaxed conditions. Our input structures need not be rigid, and our output structures may have further automorphisms beyond those induced by automorphisms of the input structure. (Received January 30, 2012)

1080-03-313 **Rumen D Dimitrov*** (rd-dimitrov@wiu.edu), Department of Mathematics, Western Illinois University, Macomb, IL 61455. *Automorphisms of substructures of the lattice of subspaces of V_∞ and derivatives*.

Metakides and Nerode introduced the study of the lattice $\mathcal{L}(V_\infty)$ of computably enumerable (c.e.) subspaces of the effective vector space V_∞ . The structure of the lattice $\mathcal{L}(V_\infty)$ is rich and $\mathcal{L}(V_\infty)$ is not merely a collection of closures of c.e. subsets of computable bases of V_∞ . But its automorphisms are relatively simple. As Guichard showed the automorphisms of $\mathcal{L}(V_\infty)$ are induced by computable semilinear transformations. The automorphisms of $\mathcal{L}^*(V_\infty)$ ($\mathcal{L}(V_\infty)/=^*$) are still not well understood. In this talk I will survey some results and methods in this area. (Received January 30, 2012)

1080-03-314 **Jan S Reimann***, Department of Mathematics, McAllister Bldg, Pennsylvania State University, University Park, PA 16802. *Degree-invariant functions and uniform Borel reductions*.

A. Kechris asked whether Turing equivalence is a universal countable Borel equivalence relation. If this is true, it would imply that Martin's Conjecture on degree-invariant functions is false. We show that Turing equivalence cannot be universal by means of uniform reductions. This is joint work with A. Montalbán and T. Slaman. (Received January 30, 2012)

1080-03-318 **Kai Maeda*** (kaimaeda@gwmail.gwu.edu), Department of Mathematics, Washington, DC 20052. *Turing degrees of isomorphic types of non-associative structures*. Preliminary report.

Richter's degree of a countable algebraic structure is a Turing degree theoretic measure of the complexity of its isomorphism class. It has been shown that some structures, such as abelian groups or partially ordered sets, have arbitrary Richter's degrees, by showing that their isomorphism classes contain infinite anti-chains of structures with certain algebraic and computability theoretic properties. I will extend these results to structures not previously studied in computability theory. (Received January 31, 2012)

1080-03-322 **Denis R. Hirschfeldt** and **Asher M. Kach*** (kach@math.uchicago.edu). *Shift Complex Reals*.

Though there are many different notions of mathematical randomness, any "random" real will have large (non-initial) segments with short descriptions. In contrast, a real is *shift complex* if no (possibly non-initial) large segment has a short description. In this talk, we review the requisite background and discuss both old and new results on shift complex reals. (Received January 31, 2012)

1080-03-324 **Uri Andrews** (andrews@math.wisc.edu), 480 Lincoln Dr, Madison, WI 53706, **Steffen Lempp*** (lemp@math.wisc.edu), 480 Lincoln Dr, Madison, WI 53706, **Joseph S Miller**, 480 Lincoln Dr, Madison, WI 53706, **Keng Meng Ng** (kmng@ntu.edu.sg), 21 Nanyang Link, Singapore, 637371, Singapore, **Luca San Mauro**, Scuola Normale Superiore, 56126 Pisa, Italy, and **Andrea Sorbi** (sorbi@unisi.it), Pian dei Mantellini, 41, 53100 Siena, Italy. *Universal computably enumerable equivalence relations*.

We study computably enumerable equivalence relations (ceers) under the reducibility $R \leq S$ if there exists a computable function f such that, for every x, y , $x R y$ if and only if $f(x) S f(y)$. We show that the degrees of ceers under the equivalence relation generated by \leq form a bounded poset that is neither a lower semilattice, nor an upper semilattice, and its first order theory is undecidable. We then study the universal ceers. We show that 1) the uniformly effectively inseparable ceers are universal, but there are effectively inseparable ceers that are not universal; 2) a ceer R is universal if and only if $R' \leq R$, where R' denotes the halting jump operator introduced by Gao and Gerdes (answering an open question of Gao and Gerdes); and 3) the index set of universal

ceers is Σ_3^0 -complete (answering an open question of Gao and Gerdes), and the index set of uniformly effectively inseparable ceers is Σ_3^0 -complete. (Received January 31, 2012)

1080-03-326 **S. M. VanDenDriessche*** (svandend@nd.edu), Department of Mathematics, University of Notre Dame, Notre Dame, IN 46556. *Turing Computable Embeddings, P-groups, and Σ_α^c Sentences*. Preliminary report.

The *Turing computable embedding*, introduced by Calvert, et al, is a formal tool used to show that the isomorphism problem for a class of structures is ‘more difficult’ than that for another class. This embedding induces a preordering on classes of countable structures. Quinn characterized which classes Turing computably embed (with respect to isomorphism) in the class of Abelian p -groups of some bounded length, denoted AB_α^p , where α is the bound. The Pull-back Theorem implies that, for a class K to Turing computably embed in AB_α^p , the structures in K must be distinguished by $\Sigma_{f(\alpha)}^c$ sentences, for some f , varying with α .

Motivated by the importance of the Σ_α^c sentences in these embeddings, we modify the Turing computable embedding to account for general equivalence relations on structures. We are particularly interested in the relation \sim , where $\mathcal{A} \sim \mathcal{B}$ if and only if \mathcal{A} and \mathcal{B} model the same Σ_α^c formulas for all computable α . We outline two approaches to showing that $\cup_\alpha AB_\alpha^p$ is a maximum of the ordering induced by the Turing computable embedding, with respect to \sim . (Received January 31, 2012)

1080-03-328 **Antonio Montalban*** (antonio@math.uchicago.edu), Dept. of Math, 5734 University Ave., University of Chicago, Chicago, IL 60637, and **Asher Kach** (kach@math.uchicago.edu), 5734 S University ave., Chicago, IL 60637. *Theories of classes of structures*.

Consider the class of all countable linear orderings. On this class we have an operation, $+$, given by the concatenation of linear orderings. We prove that the theory of this monoid is undecidable. Furthermore, we prove that it’s bi-interpretable with second-order arithmetic. We also study the classes of Boolean algebras and of groups. (Received January 31, 2012)

1080-03-330 **Wesley Calvert*** (wcalvert@siu.edu), Department of Mathematics, Mail Code 4408, 1245 Lincoln Drive, Southern Illinois Univers, Carbondale, IL 62901, and **Kunal Dutta** and **Amritanshu Prasad**. *Degeneration and orbits of tuples and subgroups*. Preliminary report.

While the structure, up to isomorphism, of finite Abelian groups is well-understood, the action of the automorphism group on such a group is not. In particular, there is a suspicious similarity with the action of the automorphism group of finite modules over other discrete valuation rings.

It turns out that some old work of Barker in calculating the back-and-forth relations for Abelian p -groups — a standard sort of calculation in computable model theory — gives us some important insights on this family of questions. It explains the similarity of the different cases, and gives us some progress toward a full classification of the orbits of the automorphism group. (Received January 31, 2012)

1080-03-334 **Robertson Bayer*** (rbayer@math.berkeley.edu), 970 Evans Hall #3840, Berkeley, CA 94720. *Low for Computational Speed*.

From the original definition of a set whose jump is as simple as possible ($A' \equiv_T 0'$), to more recent definitions involving randomness, notions of lowness appear throughout recursion theory. In that spirit, a nonrecursive set A will be said to be *low for computational speed* if for any recursive set R and any computation of R from A , there is an oracle-free computation of R that is no more than polynomial-time slower than the A -computation. An r.e. set with this property will be constructed, and properties of such sets will be discussed. This is joint work with Ted Slaman. (Received January 31, 2012)

1080-03-346 **Jennifer Chubb Reimann*** (jcchubb@usfca.edu). *Spectra of orderings of groups*. Preliminary report.

A left- or bi-ordering of a group is a linear ordering of the group elements that is invariant under the group acting on itself on the left or, respectively, both on the left and on the right. I will discuss algorithmic properties of the orderings admitted by a computable group, and consider some general questions. (Received January 31, 2012)

1080-03-360 **Harvey Friedman***, friedman@math.ohio-state.edu. *GOEDEL’S SECOND THEOREM: ITS MEANING AND USE*.

Goedel’s Second Incompleteness Theorem is a spectacular finding of the greatest general intellectual interest. The Theorem was established in the early 1930’s, and we discuss some transparent rigorous formulations that

have come much later. A weak form of the Theorem has a particularly transparent proof that provides a certain kind of information, raising the question of whether the full theorem can be treated analogously. The Theorem is used in an essential way for Concrete Mathematical Incompleteness.

The Theorem also has finite forms, which raise a number of open issues. We use Strict Reverse Mathematics to address the consistency of Peano Arithmetic. We close by comparing the inconsistency of Peano Arithmetic to such developments as spontaneous disintegration of the sun, annihilation of human life by black holes, gamma ray bursts, or comets, practical finite $P = NP$, perpetual motion machines, time travel, fast neutrinos, cold fusion, Jurassic Park, and million year life spans. (Received January 31, 2012)

1080-03-361 **Tatiana Romanovskaya***, tromanov@gwu.edu. *Godel's Incompleteness Theorems Viewed in the Wider Context of the Philosophy of Science.*

Godel's Incompleteness Theorems ushered in a renewed interest in the role of intuition in mathematics. At about the same time, we see a growing appreciation for intuition in the new physics. Even in these two contexts we can see different types of and correspondingly different roles for intuition yet in a sense clearly distinct from the way the notion was used by philosophers in the previous two centuries. I refer to this novel use as "Professional Intuition", which is complementary to and in dialogue with technical tools such as abstract models and formal theories of reliability. Some particular examples will be used to amplify these themes, drawing on the work of E. Feinberg and more recently Kevin Kelly and others. The latter, interestingly, makes use of the very notion of computational or recursion theoretic hierarchies whose origins arise directly from Godel's work on incompleteness. (Received January 31, 2012)

1080-03-362 **Laurel Marie MacMillan***, lmm8wc@virginia.edu. *Irrationality, Incommensurability, and a Paradigmatic Shift in Mathematics - Visualizing Plato's Forms.*

The discovery of irrational numbers or incommensurable lengths marked a turning point in Ancient Greek mathematical and philosophical thought. It marked a transition from the strict finitism of the Pythagoreans to the more expansive one that we eventually find in Euclid. It is widely believed that the first proofs of the existence of irrational numbers were geometric ones. I will show how these geometric proofs directly give the continued fraction representation of irrational numbers by way of the Euclidean algorithm. In ancient mathematics, these geometric constructions were seen to represent a new kind of mathematical object whose "number" is not directly observable yet whose reality could not be ignored. From our modern point view the geometric diagram or 'form' actually gives an algorithm to explicitly compute the continued fraction representation. This naturally leads to Plato's notion of form and explains the engraving on the academy door, "Let no one ignorant of geometry enter here." This view of Platonism corresponds to the one presented in W.W. Tait's *Truth and Proof: The Platonism of Mathematics*. I will give some examples so that we may actually *visualize Plato's forms* (Received January 31, 2012)

1080-03-365 **Timothy McNicholl***, timothy.h.mcnicholl@gmail.com. *Local Connectivity, Provability, and Computability.*

A topological space X is *locally connected* if, whenever U is a neighborhood of a point p of X , U contains a connected neighborhood V that contains p . We will discuss the role of effective local connectivity in the proofs of certain classical theorems on space-filling curves and extensions of conformal maps. We will then consider effective and ineffective renditions of some of these theorems and the possibilities for their reverse math strength. More specifically, we will discuss the following results:

1) There is a computably compact planar Peano continuum that is not the image of a computable map on $[0,1]$.

2) Every effectively locally connected and computably compact Euclidean Peano continuum is the image of a computable map on $[0,1]$.

3) It is well-known that the image of a continuous map on $[0,1]$ is locally connected, and the proof is fairly easy. However, there is a computable map on $[0,1]$ whose image is not effectively locally connected. Thus, this direction of the Hahn-Mazurkiewicz theorem can not be proven in BISH or in RCA_0 . We show that over RCA_0 it is equivalent to ACA_0 (arithmetic comprehension). (Received January 31, 2012)

1080-03-369 **Adam Moskey***, am2673a@student.american.edu. *Interim report on the Hilbert Bernays Project - a remarkable application.*

I will report on current work to translate Grundlagen Der Mathematik I and II. This involves publishing a commented bilingual edition of this historic work. This forms part of the overall Hilbert Bernays project. Wilfred Sieg has been one of the main editors for the project as well as one of the editors for (Volumes IV and V of) Gödel's "Collected Works." I will present (the historical research of) Sieg's paper "In the shadow

of incompleteness: Hilbert and Gentzen” where he traces the intricate connection between the two logicians, hitherto essentially unrecognized, and also makes the connection between Hilbert’s last two papers and Gödel’s incompleteness theorems. I shall frame this in a dynamic context illustrating how this shapes our understanding of logic and its history.

(Received January 31, 2012)

1080-03-371 **Dan Willard***, dew@cs.albany.edu. *On the Nature and Allowed Limited Extents of “Boundary-Case” Evasions of the Second Incompleteness Theorem.*

We have published seven papers about generalizations and unusual boundary-case exceptions for Gödel’s Second Incompleteness Theorem during 2001-2009

Hilb-2.1 : : “*Purist*” *Question*: What kinds of arithmetics, if any can look at themselves and formalize some *strong* sense of their own consistency?

Hilb-2.2 : : *The “Computer-Oriented” Question*: Are there some (perhaps weak senses) where any axiom system α can possess a sufficient *weakened form* of knowledge of its own consistency, so as to assist an automated theorem prover, which tries to predict its own theorem proving abilities, when using α as its axiom base?

There is essentially a definitive negative answer to question Hilb-2.1. At the same time, both Gödel and Hilbert expressed ambivalence about fully embracing the Second Incompleteness Theorem. It is for this reason that Hilb-2.2’s revision of Hilbert’s Second Open Question becomes of interest. Our self-justifying axiom systems are certainly incapable of verifying their own consistency in a strong idealized sense: They do provide, however, some partial positive results for the Question 2.2 when the germane axiom system and deduction method are sufficiently weakened. (Received January 31, 2012)

1080-03-373 **Jeffrey Sarnat***, jeffrey.sarnat@gmail.com. *Syntactic Finitism and its Metatheory.*

One of the central goals of programming-language research is to develop mathematically sound formal methods for precisely specifying and reasoning about the behavior of programs. The boundary between trusted and untrusted reasoning principles is inherently blurry, and different researchers draw the line in different places. However, just as certain principles are widely recognized to allow the proofs of contradictory statements, others are so uncontroversially ubiquitous in practice that they can be considered beyond reproach. In this talk, we posit the following questions: (1) what are these principles and (2) how much can we do with them?

Although neither has an uncontroversial answer, we propose an answer to the former by describing a viewpoint we refer to as “syntactic finitism,” (heavily influenced by Gentzen’s version of finitism) in which we take the principles of case analysis and structural induction on abstract syntax as our starting point. We explore the latter question by giving a proofs-as-logic-programs formalization of syntactic finitism, and analyze the expressivity of this approach using some of the ideas and results from ordinal analysis (spoiler: the resulting bound is $\omega^{\omega^{\omega}}$). (Received January 31, 2012)

1080-03-376 **Mark Lance***, lancem@georgetown.edu, and **K J Mourad**, kjm57@georgetown.edu. *On W.W. Tait’s Finitism and Hilbert’s Program.*

Is Hilbert’s program unsalvageable? The conventional answer is ‘yes’, not merely as a consequence of Gödel’s 2nd Incompleteness theorem, but also on the basis of an influential analysis of Hilbert’s conception of finitism by W.W. Tait. His analysis in the landmark paper “Finitism” has been one of the pillars of our current picture of the foundations of mathematics, and has largely functioned to define the terms in which questions of the viability of Hilbert’s program are posed. It has even been suggested that this characterization is analogous to Turing’s analysis of the notion of computation. Tait himself, however, warns us against such a facile conclusion, at least not until a more careful and thorough evaluation is given of his paper and its ideas. We propose to give “Finitism” as well as Tait’s other work on this theme the attention they are due. We offer a careful reading of the argument of “finitism” and related papers - including Tait’s arguments against some of Gödel’s views concerning finitism - and suggest that the prospects for carrying out Hilbert’s program are not as grim as is commonly thought. (Received January 31, 2012)

1080-03-378 **K J Mourad*** (kjm57@georgetown.edu), kjm57@georgetown.edu. *Finite Set Theories and Hilbert’s Finitism.*

In the context of set theory, Hilbert’s Finitism can be interpreted using set theories for which there are no infinite sets. Even there one can take the Gödel Bernays approach and allow proper classes which may be infinite although the sets themselves remain finite. We consider such approaches and survey some recent results in this area.

An interesting phenomena occurs when we attempt to compare such theories to finitistic theories in other settings such as first and second order arithmetic. In order to make a fair comparison we must appeal to certain notions of interpretation. Such considerations bring up interesting questions on the nature of finitism itself as well as certain philosophical issues related to domains of quantification. (Received February 01, 2012)

05 ► Combinatorics

1080-05-9 **Steven J Miller*** (sjm1@williams.edu), Department of Mathematics and Statistics, Williams College, Williamstown, MA 01267, and **Yinghui Wang** (yw2450@columbia.edu), Department of Mathematics, Columbia University, New York, NY 10027. *Distribution of Summands in Generalized Zeckendorf Decompositions, I.*

A beautiful theorem of Zeckendorf states that every positive integer can be written uniquely as a sum of non-consecutive Fibonacci numbers. Once this has been shown, it is natural to ask how many Fibonacci numbers are needed. Lekkerkerker proved that the average number of such summands needed for integers in $[F_n, F_{n+1})$ is $n/(\phi^2 + 1)$, where ϕ is the golden mean. We present a combinatorial proof of this through the cookie problem and differentiating identities, and show that the gaps between summands follow a geometric distribution with decay parameter ϕ . These techniques apply to numerous generalizations, which we'll discuss. This is joint work with Olivia Beckwith. (Received September 14, 2011)

1080-05-18 **Chris Berg*** (cberg@lacim.ca), **Nantel Bergeron**, **Hugh Thomas** and **Mike Zabrocki**. *Expansions of k -Schur functions in the affine nil Coxeter algebra.*

Lam showed that the k -Schur functions model Schubert classes for the homology of the affine Grassmanian in type A. This was done by constructing an isomorphism between the homology and a subalgebra of the nil Coxeter algebra. Explicit formulas for the Schubert classes in the nil Coxeter algebra have not been constructed. I will speak on how this generalizes to a definition of k -Schur functions in all types, and how to get explicit formulas in certain cases. (Received October 22, 2011)

1080-05-23 **Carolyn Chun*** (chchchun@gmail.com), MSOR, PO Box 600, Wellington, 6140, New Zealand, and **Dillon Mayhew**, **Geoff Whittle** and **Stefan van Zwam**. *Fragility in matroids.*

For a matroid M with a minor N , we say that M is N -fragile if, for every element e in the ground set of M , either M/e or $M \setminus e$ does not contain N as a minor. Understanding the structure of N -fragile matroids is necessary for thinking about Rota's conjecture. In this talk, we present a characterization of the binary, Fano-fragile matroids. (Received November 20, 2011)

1080-05-47 **Patricia Hersh*** (plhersh@ncsu.edu), Patricia Hersh, Box 8205, NCSU, Raleigh, NC 27695-8205, and **Anne Schilling** (anne@math.ucdavis.edu). *Symmetric chain decomposition for cyclic quotients of Boolean algebras.*

The quotient of a Boolean algebra by a cyclic group is proven to have a symmetric chain decomposition. This generalizes earlier work of Griggs, Killian and Savage on the case of prime order, giving an explicit construction for any order, prime or composite. The combinatorial map specifying how to proceed downward in a symmetric chain is shown to be a natural cyclic analogue of Kashiwara's sl_2 lowering operator in the theory of crystal bases. This is joint work with Anne Schilling. (Received December 16, 2011)

1080-05-50 **Kurt W. Luoto*** (kwluoto@gmail.com). *Colored quasisymmetric and noncommutative Schur functions.*

In previously published work, C. Bessenrodt, J. Haglund, S. Mason, S. van Willigenburg, and this author defined analogs of the Schur functions in the quasisymmetric function algebra (QSym) and in the noncommutative symmetric function algebra (NSym), and presented Littlewood-Richardson rules for them. In this talk I will discuss how these analogs generalize respectively to the colored QSym algebra of Poirier and to the Mantaci-Reutenauer algebra. (Received December 21, 2011)

1080-05-53 **Adam J Gilbert*** (adamgilbert@math.uri.edu). *Representing Asteroidal Sets on Subdivisions of $K_{1,n}$.* Preliminary report.

The study of graph representations is an active research area in Graph Theory. Given a graph $G = (V, E)$, a representation of G is the following collection of objects: (1) a Host Set S , (2) an Assignment function $f : V \rightarrow \mathcal{P}(S)$, and (3) a Conflict Rule $g : f(V) \times f(V) \rightarrow \{0, 1\}$ so that $g(f(v_1), f(v_2)) = 1$ iff $(v_1, v_2) \in E$. We say that a graph G is representable under a given host set S and conflict rule g if there exists a suitable

assignment function f . The existence of certain sub-structures can make a graph difficult to represent. One such structure is an Asteroidal Set.

An **asteroidal set** in a graph is $A \subset V$ so that $\forall v_1, v_2, v_3 \in A, \exists P(v_i, v_j) \ni P(v_i, v_j) \cap N(v_k) = \emptyset$

We consider Tree Representations of a graph G . That is, a representation where the ‘Host Set’ is a tree T , subsets assigned to vertices of a representable graph G must be sub-trees of T , and the conflict rule depends on an intersection threshold.

We show that given a host tree, T , which is a subdivision of $K_{1,n}$ and a conflict tolerance t , the largest asteroidal set representable on T is of size $n + \sum_{k=2}^n \binom{n}{k} \binom{t-2}{k-1}$. (Received December 23, 2011)

1080-05-57 **Jeffrey Remmel** (jremmel@ucsd.edu), Dept. Math MC 0112, 9500 Gilman Drive, La Jolla, CA 92093, and **Meesue Yoo*** (meesue@gmail.com), Dept. Math, KIAS, 85 Hoegiro, Dongdaemoon-gu, Seoul, 130-722, South Korea. *The combinatorics of the HMZ operators applied to Schur functions.*

Haglund, Morse, and Zabrocki introduced a family of symmetric function operators $\{\mathbb{B}_m\}_{m \geq 1}$ and $\{\mathbb{C}_m\}_{m \geq 1}$ which are closely related to operators of Jing. Haglund, Morse, and Zabrocki used these operators to refine the shuffle conjecture of Haglund, Haiman, Loehr, Remmel and Ulyanov which gives a combinatorial interpretation of the coefficient of the monomial symmetric function in the Frobenius image of the character generating function of the ring of diagonal harmonics. In this talk, we give combinatorial interpretations of the coefficients that arise in Schur function expansion of $\mathbb{B}_m s_\lambda[X]$ and $\mathbb{C}_m s_\lambda[X]$ where $s_\lambda[X]$ is the Schur function associated to the partition λ . We then use such combinatorial interpretations to give a new recursion for the Kostka-Foulkes polynomials $K_{\lambda,\mu}(q)$. (Received December 27, 2011)

1080-05-67 **Tyler Moss*** (jmoss11@math.lsu.edu). *A minor-based characterization of matroid 3-connectivity.*

It is well known that a matroid is 2-connected if and only if every 2-element set is contained in a circuit, or equivalently, a $U_{1,2}$ -minor. This talk will give an analogous result for matroid 3-connectivity. (Received January 05, 2012)

1080-05-75 **Elizabeth Niese*** (niese@marshall.edu), Huntington, WV 25755. *An injection from standard fillings to parking functions.*

It is known that the Garsia-Haiman module, M_μ , is a submodule of the module of diagonal harmonics, DH_n . The Hilbert series of M_μ can be written using Haglund’s combinatorial definition as a weighted sum of standard fillings of the ferrers diagram of μ . It is conjectured by Haglund and Loehr that the Hilbert series of DH_n can be written as a weighted sum of parking functions. Thus, there should be a weight-preserving injection from standard fillings to parking functions. We present such an injection for certain cases. (Received January 10, 2012)

1080-05-86 **Sul-young Choi*** (sulyoung@lemoyne.edu), Dept of Math and Computer Science, Le Moyne College, 1419 Salt Springs Rd, Syracuse, NY 13214, and **Puhua Guan** (pu2guan@yahoo.com), Department of Mathematics, University of Puerto Rico, Rio Piedras, PR 00931. *On the existence of graphs with homogeneous neighborhood labeling.*

In this talk, we discuss labeled graphs with a certain type of homogeneity. A vertex labeling of a graph is an (a, b) -homogeneous neighborhood vertex labeling (NVL) if a closed neighborhood of each vertex is labeled using a labels with each label appearing exactly b times. A (c, d) -homogeneous neighborhood edge labeling (NEL) is defined similarly. A graph is $(a, b; c, d)$ -NL (neighborhood labeled) if it has both (a, b) -NVL and (c, d) -NEL. In general the homogeneous vertex- (or edge-) labeling does not satisfy the usual labeling/coloring condition, i.e., any adjacent vertices (edges) do not share a same label. The homogeneity of an NL graph implies the regularity and somewhat uniform local structure of a graph. One can easily show that there exists no $(2,1;2,1)$ -NL graph. It is known that there exist two $(2,2;2,2)$ -NL graphs with 12 vertices and nine $(2,2;2,2)$ -NL graphs with 24 vertices. In this talk we show via construction the existence of $(a, b; c, d)$ -NL graphs with $2a(ab-p)p$ vertices where a, b, c, d and p are positive integers satisfying $cd = \frac{(ab-p)(ab-p-1)}{2} + p$ and $p < b$. (Received January 11, 2012)

1080-05-87 **Oleg Borodin** and **Alexandr Kostochka***, kostochk@math.uiuc.edu. *Improper 2-colorings of sparse graphs.* Preliminary report.

We consider one of the simplest kinds of improper colorings – colorings with two colors. A graph G is (j, k) -colorable if its vertices can be partitioned into subsets V_1 and V_2 such that in $G[V_1]$ every vertex has degree at most j and in $G[V_2]$ every vertex has degree at most k . We prove that every graph with the maximum average

degree at most $\frac{12}{5}$ is $(1, 0)$ -colorable and that if $k \geq 2j + 2$, then every graph with maximum average degree at most $2 \left(2 - \frac{k+2}{(j+2)(k+1)} \right)$ is (j, k) -colorable. Both bounds are sharp. (Received January 11, 2012)

1080-05-90 **Nick Zhao*** (yzhao@mail.ucf.edu), Department of Mathematics, University of Central Florida, Orlando, FL 32816. *On Vizing's 2-Factor Conjecture.*

In 1965, Vizing proposed the following conjecture which claims that every edge chromatic critical graph has a 2-factor. If this conjecture is true, then Vizing's Independence Number Conjecture proposed in 1968 is true. For a long time, there had been no progress towards this 2-factor conjecture until 2004. In this talk, we will present a new result about this 2-factor conjecture and show that if G is an edge chromatic Δ -critical graph with n vertices satisfying $\Delta \geq \frac{6n}{7}$, then G is Hamiltonian and thus G has a 2-factor. (Received January 12, 2012)

1080-05-91 **Philip Bonneville, Eddie Cheng and Joseph Renzi*** (gdrenzi@aol.com). *Strong matching preclusion for the alternating group graphs and split-stars.*

The strong matching preclusion number of a graph is the minimum number of vertices and edges whose deletion results in a graph that has neither perfect matchings nor almost-perfect matchings. This is an extension of the matching preclusion problem and has recently be introduced by Park and Ihm. In this paper, we examine properties of strong matching preclusion for alternating group graphs, by finding its strong matching preclusion number and categorizing all optimal solutions. More importantly, we prove a general result on taking a Cartesian product of a graph with an edge to obtain the corresponding results for split-stars. (Received January 12, 2012)

1080-05-93 **Rong Luo*** (rluo@mtsu.edu), Department of Mathematical Sciences, Middle Tennessee State University, Murfreesboro, TN 37130. *The size of edge chromatic critical graphs.*

Vizing conjectured in 1968 that for each edge chromatic critical G with maximum degree Δ , $m \geq \frac{1}{2}\{n(\Delta-1)+3\}$ where m and n are the numbers of edges and vertices, respectively. In this talk, we will present a new lower bound on the size of critical graphs. This is joint work with Yue Zhao. (Received January 12, 2012)

1080-05-94 **Joseph P.S. Kung*** (kung@unt.edu), Department of Mathematics, P.O. Box 311430, Denton, TX 76203-1430. *Is the bicycle dimension of a matrix an invariant of the field and the column matroid?* Preliminary report.

A matrix H is orthogonally dual to the matrix G if H and G have the same column set E , H is a matrix of rank $|E| - \text{rank}(G)$, and if u is a row of G and v is a row of H , the inner product $\langle u, v \rangle = \sum_{e \in E} u_e v_e$ equals 0. The bicycle dimension $d(G)$ of a matrix G with column set E is the dimension of the intersection of the row space of G and the row space of H . The bicycle dimension is always 0 over a field of characteristic 0. We will discuss the question whether the bicycle dimension of G is determined by the field and the column matroid of G . (Received January 12, 2012)

1080-05-96 **George E. Andrews and Eric S. Egge*** (eegge@carleton.edu), Department of Mathematics, Carleton College, Northfield, MN 55057, and **Wolfgang Gawronski and Lance L. Littlejohn.** *The Jacobi-Stirling Numbers.*

The Jacobi-Stirling numbers of the second kind are a one-parameter analogue of the classical Stirling numbers of the second kind which first arose in the study of the spectral powers of the classical second-order Jacobi differential expression. Recently several people have introduced Jacobi-Stirling numbers of the first kind, which are analogues of the Stirling numbers of the first kind, and given various combinatorial interpretations of the Jacobi-Stirling numbers of both kinds. The Jacobi-Stirling numbers have also been found to have connections with symmetric functions and P-partitions. In this talk I will describe many of these recent developments, along with some open questions. (Received January 14, 2012)

1080-05-100 **Tricia Muldoon Brown*** (patricia.brown@armstrong.edu), Armstrong Atlantic State University, 11935 Abercorn St, Savannah, GA 31419. *A symmetric group representation of the Rees product of the cubical lattice with the chain.*

Using poset homology techniques we find an explicit basis for the reduced homology of the order complex of the Rees product of the cubical lattice with the chain and determine a representation of the reduced homology of this order complex over the symmetric group. We conclude with generalizations to r -cubical lattices. (Received January 15, 2012)

1080-05-109 **Manoel J M S Lemos*** (mjmslemos@gmail.com), Departamento de Matemática, Universidade Federal de Pernambuco, Cidade Universitária, Recife, Pernambuco 50740-540, Brazil. *Non-separating cocircuits in binary matroids.*

A cocircuit of a connected binary matroid is *non-separating* provided its deletion originates a connected minor. Edmonds conjectured that each element of a 3-connected binary matroid belongs to at least two non-separating cocircuits. Moreover, a 3-connected binary matroid is graphic if and only if each element belongs to exactly two non-separating cocircuits. These conjectures were proved by Bixby and Cunningham. For connected binary matroids, the picture is completely different.

Kelmans and Seymour independently established that a simple and cosimple connected binary matroid has at least one non-separating cocircuit. McNulty and Wu improved this lower bound to four. Lemos and Melo proved that the non-separating cocircuits of such matroid are the non-separating cocircuits of few 3-connected minors avoiding some elements.

In this talk, we discuss results about non-separating cocircuits in 3-connected binary matroids with emphasis on these that avoids a fixed set. (Received January 17, 2012)

1080-05-114 **Bert Gerards*** (bert.gerards@cwi.nl). *Characterizing graphic matroids by a system of linear equations.* Preliminary report.

Given a rank- r binary matroid we construct a system of $O(r^3)$ linear equations in $O(r^2)$ variables that has a solution over $\text{GF}(2)$ if and only if the matroid is graphic. This is joint work with Jim Geelen. (Received January 18, 2012)

1080-05-121 **Jesse Taylor*** (JTAYL75@math.lsu.edu). *On a class of nearly binary matroids.*

We give an excluded-minor characterization for the class of matroids \mathcal{Z} such that a matroid M is in \mathcal{Z} if and only if M/e or $M \setminus e$ is binary for all e in $E(M)$. The class \mathcal{Z} is closely related to the class of matroids in which every member is binary or can be obtained from a binary matroid by relaxing a circuit-hyperplane. We also provide an excluded-minor characterization for the second class. (Received January 19, 2012)

1080-05-128 **Carolyn Chun, Dillon Mayhew and James Oxley*** (oxley@math.lsu.edu). *Towards a Splitter Theorem for Internally 4-connected Binary Matroids.*

Two powerful inductive tools for dealing with 3-connected matroids are Tutte's Wheels-and-Whirls Theorem and Seymour's Splitter Theorem. The first shows that it is always possible to remove one or two elements from a 3-connected matroid M to get another 3-connected matroid. The second shows that such removals can be done to maintain not only 3-connectivity but also a copy of a specified 3-connected minor of M . For several years, we have been seeking analogues of these theorems for internally 4-connected binary matroids. In 2011, we found such an analogue of Tutte's Wheels-and-Whirls Theorem. This talk will describe our ongoing work towards an analogue of the Splitter Theorem. (Received January 20, 2012)

1080-05-138 **Gary Gordon*** (gordong@lafayette.edu), 229 Pardee Hall, Lafayette College, Easton, PA 18042. *Matroids, greedoids and the Tutte polynomial.* Preliminary report.

We present some conjectures and counterexamples related to the greedoid generalization of the Tutte polynomial of a matroid. In particular, we give simple examples to show the Tutte polynomial does not distinguish greedoids. We also study the affine relations satisfied by the coefficients of the Tutte polynomial in this more general setting. (Received January 21, 2012)

1080-05-140 **Guoli Ding** (ding@math.lsu.edu), Louisiana State University, **Stan Dziobiak** (smdziobi@olemiss.edu), University of Mississippi, and **Haidong Wu*** (hwu@olemiss.edu), University of Mississippi. *Large minors and circumference of 3-connected cographic matroids.* Preliminary report.

Oporowski, Oxley and Thomas prove the following result. For any integer n greater than two, there is an N such that every 3-connected graph with at least N vertices contains a W_n or $K_{3,n}$ -minor. We prove a strengthening of this result. We also obtain a lower bound on the circumference of 3-connected cographic matroids. (Received January 21, 2012)

1080-05-148 **Shannon Overbay*** (overbay@gonzaga.edu). *Embedding graphs in cylinder and torus books.*

In the classical book embedding problem a k -book is defined to be a line L in 3-space (the spine) together with k half-planes (the pages) joined together at L . We consider two variations on the classic book in which edges are allowed to wrap in either one or two directions. The first is a cylindrical book where the spine is a line L in 3-space and the pages are concentric cylindrical shells joined together at L . The second is a torus book where

the spine is a ring on R a torus and the pages are concentric torus shells joined together at R . We give edge bounds for embeddings of finite simple graphs on cylinder and torus books and give optimal embeddings of K_n . We also compare both books with the classical book. (Received January 22, 2012)

1080-05-153 **Ronald J. Gould*** (rg@mathcs.emory.edu), Department of Math and CS, Emory University, Atlanta, GA 30322. *On Chorded Cycles*. Preliminary report.

A *chord* in a cycle is an edge between nonconsecutive vertices of the cycle. There are many results about the existence of cycles, collections of cycles, or 2-factors. But there are far fewer results about the existence of chorded cycles or collections of chorded cycles. We survey what is known about chorded cycles and present a new degree sum result about the existence of a collection of k doubly chorded cycles. (Received January 23, 2012)

1080-05-172 **Dennis W Hall*** (dhall15@math.lsu.edu). *Unavoidable minors for connected 2-polymatroids*.

It is well known that, for any integer n greater than one, there is a number r such that every 2-connected simple graph with at least r edges has a minor isomorphic to an n -edge cycle or $K_{2,n}$. This result was extended to matroids by Lovász, Schrijver, and Seymour who proved that every sufficiently large connected matroid has an n -element circuit or an n -element cocircuit as a minor. In this talk, we generalize these theorems by providing an analogous result for connected 2-polymatroids. (Received January 25, 2012)

1080-05-182 **James M. Carraher*** (s-jcarrah1@math.unl.edu) and **Stephen G. Hartke**. *Compatible circuits in eulerian digraphs*.

Let G be an eulerian digraph with a fixed coloring (not necessarily a proper edge coloring). A compatible circuit T is an eulerian circuit of G such that no two consecutive edges in the circuit have the same color. We provide necessary and sufficient conditions that determine the existence of a compatible circuit for most instances. For the remaining cases, we show examples of digraphs both with and without compatible circuits that indicates the hardness of the problem. (Received January 26, 2012)

1080-05-187 **Oleg Borodin, Alexandr Kostochka** and **Matthew Yancey*** (yancey1@illinois.edu), 1409 W. Green Street, Urbana, IL 61801. *On 1-improper 2-coloring of sparse graphs*.

A graph G is (j, k) -colorable if $V(G)$ can be partitioned into V_1 and V_2 such that the maximum degree of $G[V_1]$ is at most j and the maximum degree of $G[V_2]$ is at most k . Recently Borodin and Kostochka showed that for $k \geq 2j + 2$, every graph with maximum average degree at most $2 \left(2 - \frac{k+2}{(j+2)(k+1)} \right)$ is (j, k) -colorable, and this is sharp. They also gave a sharp bound for $(0, 1)$ -colorable graphs. We prove that every graph with maximum average degree at most 2.8 is $(1, 1)$ -colorable. This bound is sharp and different from the formula above. (Received January 26, 2012)

1080-05-193 **Charles Semple*** (charles.semple@canterbury.ac.nz), Department of Mathematics and Statistics, University of Canterbury, Christchurch, 8140, New Zealand. *What is a typical matroid?*

If one selects an n -element labelled matroid uniformly at random, what properties can one expect it to have when n is sufficiently large? Does it have high connectivity? What about its rank? How many bases does it have? For labelled graphs, the analogous problem has been well-studied but, for labelled matroids, the problem is largely unexplored. In this talk, we investigate this problem and discuss some recent results. (Received January 26, 2012)

1080-05-214 **Xiangqian Joe Zhou*** (xiangqian.zhou@wright.edu), Wright State University, 3640 Colonel Glenn Hwy, Dayton, OH 45435. *On minimally k -connected matroids*.

A matroid M is *minimally k -connected* if M is k -connected and, for every $e \in E(M)$, $M \setminus e$ is not k -connected. It is conjectured that every minimally k -connected matroid with at least $2(k - 1)$ elements has a cocircuit of size k . We resolve the conjecture almost affirmatively for the case $k = 4$ by finding the unique counterexample; and for each $k \geq 5$, we prove that there exists a counterexample to the conjecture with $2k + 1$ elements. This is joint work with James Reid and Haidong Wu. (Received January 27, 2012)

1080-05-215 **Aaron Lauve** and **Sarah Mason*** (masonsk@wfu.edu). *Between quasisymmetric and symmetric functions*. Preliminary report.

Hivert recently introduced a class of local actions of the symmetric group which are used to produce an infinite family of Hopf algebras interpolating between quasisymmetric and symmetric functions. We introduce a new

collection of bases, one for each such family, and describe their relationship to a conjecture of Bergeron and Reutenauer about the coinvariant rings of these families. (Received January 27, 2012)

1080-05-219 **Mahir Bilen Can*** (mcan@tulane.edu), 6823 St. Charles Ave., New Orleans, LA 70118, and **Kursat Aker**, Istanbul, Turkey. *Branching of twisted representations of symplectic groups*. Preliminary report.

Signature quantization, whose formalism developed by Guillemin, Sternberg and Weitsman has importance in symplectic geometry. Irreducible representations of signature quantized Lie groups are called twisted representations. Extending an earlier work of Rassart and Guillemin on twisted representations in type A, using symplectic Schur functions, we compute the branching multiplicities for symplectic groups. (Received January 27, 2012)

1080-05-224 **Talmage James Reid*** (mmreid@olemiss.edu), The University of Mississippi, Department of Mathematics, University, MS 38655, **Haidong Wu** (hwu@olemiss.edu), Department of Mathematics, University, MS 38655, and **Kayla Davis**, The University of Mississippi. *Regular matroids excluding some small graph minors*. Preliminary report.

Guoli Ding and Cheng Liu characterized the 3-connected graphs excluding each of the 3-connected graphs on eleven edges. These results continue a program of Dirac, Wagner, Hall, and others, that consider characterizations of such classes of graphs. We extend some of Ding and Liu's results to regular matroids. (Received January 27, 2012)

1080-05-226 **Gregory S. Warrington*** (gregory.warrington@uvm.edu), Department of Mathematics, 16 Colchester Ave., Burlington, VT 05401. *On quasisymmetric expansions*.

I will discuss some problems related to expansions in terms of fundamental quasisymmetric functions and the relation to Schur expansions. (Received January 27, 2012)

1080-05-235 **Camillia Smith Barnes*** (cbarnes@sbc.edu), PO Box 74, Sweet Briar, VA 24595-0074. *Shuffles of Permutations*. Preliminary report.

A shuffle of words is obtained by interleaving the letters of the words in such a way that the letters of each original word remain in order. Shuffles of the words 1234 and 5678 include 12536784 and 51672834. In this talk, we discuss results on shuffles of permutations. (Received January 28, 2012)

1080-05-238 **Ben Clark*** (clarkbenj@myvuw.ac.nz) and **Geoff Whittle**. *Tangles, Trees, and Flowers*.

A tangle of order k in a matroid or graph may be thought of as a " k -connected component". For a tangle of order k in a matroid or graph that satisfies a certain robustness condition, we describe a tree decomposition of the matroid or graph that displays, up to a certain natural equivalence, all of the k -separations of the matroid or graph that are non-trivial with respect to the tangle. (Received January 28, 2012)

1080-05-240 **Bert Gerards, Tony Huynh and Stefan H.M. van Zwam*** (svanzwam@math.princeton.edu). *Menger's Theorem for Matroids, doubled*. Preliminary report.

Tutte's Linking Theorem is a generalization of Menger's Theorem from graphs to matroids. It has proven to be of great value in the study of matroid connectivity.

Let S and T be disjoint subsets of the groundset of a matroid M . The *connectivity* between S and T , denoted $\kappa_M(S, T)$, is the minimum order of a separation (X, Y) with $S \subseteq X$ and $T \subseteq Y$. Tutte's Linking Theorem states that, for all elements e outside S and T , at least one of $M \setminus e$ and M/e has the same connectivity between S and T as M .

In this talk we have two pairs of subsets, (S_1, T_1) and (S_2, T_2) , of the groundset of M . We show that, if M is sufficiently large and representable over a finite field, we can find an element e such that in one of $M \setminus e$ and M/e both connectivities are preserved.

We conjecture that the bound on the size of M does not depend on the field. (Received January 28, 2012)

1080-05-241 **Timothy D. LeSaulnier and Douglas B. West***, Mathematics Department, University of Illinois, Urbana, IL 61801-2975. *Rainbow edge-coloring and rainbow domination*.

Let G be an edge-colored graph with n vertices. A *rainbow subgraph* is a subgraph whose edges have distinct colors. The *rainbow edge-chromatic number* of G , written $\hat{\chi}'(G)$, is the minimum number of rainbow matchings needed to cover $E(G)$. An edge-colored graph is t -tolerant if it contains no monochromatic star with $t+1$ edges. If G is t -tolerant, then $\hat{\chi}'(G) < t(t+1)n \ln n$, and examples exist with $\hat{\chi}'(G) \geq \frac{t}{2}(n-1)$. The *rainbow domination number*, written $\hat{\gamma}(G)$, is the minimum number of disjoint rainbow stars needed to cover $V(G)$. For t -tolerant edge-colored n -vertex graphs, we generalize classical bounds on the domination number: (1) $\hat{\gamma}(G) \leq \frac{1+\ln k}{k} n$

(where $k = \frac{\delta(G)}{t} + 1$), and (2) $\hat{\gamma}(G) \leq \frac{t}{t+1}n$ when G has no isolated vertices. We also characterize the edge-colored graphs achieving equality in the latter bound. (Received January 28, 2012)

1080-05-244 **Edward Boehnlein** and **Tao Jiang*** (jiangt@muohio.edu), Department of Mathematics, Miami University, Oxford, OH 45056. *Set families with a forbidden induced subposet.*

Sperner's Theorem asserts that the largest antichain in a Boolean lattice B_n has size $\binom{n}{\lfloor n/2 \rfloor}$. Recently, Bukh proved a substantial asymptotic extension of Sperner's theorem by proving that for any poset H whose Hasse diagram is a tree of height k , the largest size of a subfamily of B_n not containing H as a subposet (as a function of n) is asymptotic to $(k-1)\binom{n}{\lfloor n/2 \rfloor}$. When H is the poset consisting of three elements a, b, c with $a \leq b, a \leq c$, Carroll and Katona were able to establish an induced version of Bukh's result. Here, we establish an induced version of Bukh's result for all posets H whose Hasse diagram is a tree. We show that for any poset H whose Hasse diagram is a tree of height k , the largest size of a subfamily of B_n not containing H as an induced subposet is asymptotic to $(k-1)\binom{n}{\lfloor n/2 \rfloor}$. (Received January 28, 2012)

1080-05-253 **Gregg Musiker*** (musiker@math.umn.edu). *Bipartite Graphs, Quivers, and Cluster Variables.*

We discuss work of In-Jee Jeong, an REU student mentored by the speaker at UMN in summer 2011. This work provides combinatorial formulas for Laurent expansions of certain cluster variables for certain periodic quivers. In particular the formulas illustrated use weighted sums of perfect matchings of certain bipartite graphs and provide variants of previously known formulas involving Aztec Diamonds. (Received January 29, 2012)

1080-05-261 **Sandra Kingan*** (skingan@brooklyn.cuny.edu), Department of Mathematics, Brooklyn College, CUNY, 2900 Bedford Avenue, New York, NY 11210, and **Manoel Lemos** (manoel@dmf.ufpe.br), Departamento de Matematica, Universidade Federal de Pernambuco, Recife, Pernambuco 50740-540, Brazil. *Strong Splitter Theorem.*

We present a strengthening of the Splitter Theorem and some of its applications to excluded minor results. The Splitter Theorem states that, if N is a 3-connected proper minor of a 3-connected matroid M such that, if N is a wheel or whirl then M has no larger wheel or whirl, respectively, then there is a sequence M_0, \dots, M_n of 3-connected matroids with $M_0 \cong N$, $M_n = M$ and for $i \in \{1, \dots, n\}$, M_i is a single-element extension or coextension of M_{i-1} . Observe that there is no condition on how many extensions may occur before a coextension must occur. We strengthen it, as a result of which we can obtain, up to isomorphism, M starting with N and at each step doing a 3-connected single-element extension or coextension, such that at most two consecutive single-element extensions occur in the sequence (unless the rank of the matroids involved are $r(M)$). Moreover, if two consecutive single-element extensions by elements $\{e, f\}$ are followed by a coextension by element g , then $\{e, f, g\}$ form a triad in the resulting matroid. (Received January 29, 2012)

1080-05-268 **Carsten Thomassen**, **Yezhou Wu** and **Cun-Quan Zhang*** (cqzhang@math.wvu.edu), Department of Mathematics, Morgantown, WV 26506-6310. *3-flows for 6-edge-connected graphs.*

It was conjectured by Tutte (1970's) that every 4-edge connected graph admits a nowhere-zero 3-flow. Jaeger, Linial, Payan and Tarsi (1992 JCTB) further conjectured that every 5-edge-connected graph is Z_3 -connected. A weak version of the 3-flow conjecture was proposed by Jaeger (1979) that there is an integer h such that every h -edge-connected graph admits a nowhere-zero 3-flow. Thomassen (JCTB to appear) recently solved this open problem by proving that every 8-edge-connected graph is Z_3 -connected and admits a nowhere-zero 3-flow. In this paper, Thomassen's result is further improved that *every 6-edge-connected graph is Z_3 -connected and admits a nowhere-zero 3-flow*. Note that it was proved by Kochol (2001 JCTB) that it suffices to prove the 3-flow conjecture for 5-edge-connected graphs. (Joint work with C. Thomassen, Y. Wu) (Received January 29, 2012)

1080-05-281 **Jie Ma** and **Xingxing Yu*** (yu@math.gatech.edu), School of Mathematics, Georgia Institute of Technology, Atlanta, GA 30332. *Judicious bipartitions of graphs.*

For a positive integer m , let $f(m)$ be the maximum value t such that any graph with m edges has a bipartite subgraph of size at least t , and let $g(m)$ be the minimum value s such that for any graph G with m edges there exists a bipartition $V(G) = V_1 \cup V_2$ such that G has at most s edges with both incident vertices in V_i . Alon proved that the limsup of $f(m) - (m/2 + \sqrt{m/8})$ tends to infinity as m tends to infinity, establishing a conjecture of Erdős. Bollobás and Scott proposed the following judicious version of Erdős' conjecture: the limsup of $m/4 + \sqrt{m/32} - g(m)$ tends to infinity as m tends to infinity. We confirm this conjecture. We also generalize

Alon's result to k -partitions, which should be useful for generalizing the above Bollobás-Scott conjecture to k -partitions. (Received January 30, 2012)

1080-05-282 **Guantao Chen*** (gchen@gsu.edu), Department of Mathematics and Statistics, Georgia State University, Atlanta, GA 30303, and **Songling Shan**, Department of Mathematics and Statistics, Georgia State University, Atlanta, GA 30303. *Homeomorphically Irreducible Spanning Trees.*

Let G be a graph. A spanning tree of G is called a *homeomorphically irreducible spanning tree* (HIST) if it does not contain vertices of degree 2. In 1979, Albertson, Berman, Hutchinson, and Thomassen asked the following two questions:

- (1) Does every triangulation of a surface contain a HIST except the triangle?
- (2) Does every graph with every edge on two triangles contain a HIST?

We have confirmed both questions positively. The outlines of the proofs will be given in this talk. (Received January 30, 2012)

1080-05-290 **Jozsef Balogh** (jobal@math.uiuc.edu), **Ping Hu** (pinghu1@math.uiuc.edu) and **Bernard Lidicky*** (lidicky@illinois.edu), Department of Mathematical Sciences, 1409 W. Green St., Urbana, IL 61801, and **Hong Liu** (hliu36@illinois.edu). *Upper bounds on the size of 4- and 6-cycle-free subgraphs of the hypercube.*

In this paper we modify slightly Razborov's flag algebra machinery to be suitable for the hypercube. We use this modified method to show that the maximum number of edges of a 4-cycle-free subgraph of the n -dimensional hypercube is at most 0.6068 times the number of its edges. We also improve the upper bound on the number of edges for 6-cycle-free subgraphs of the n -dimensional hypercube from $\sqrt{2} - 1$ to 0.3755 times the number of its edges. (Received January 30, 2012)

1080-05-293 **Garth Isaak*** (gisaak@lehigh.edu). *Degrees in Edge Colored Graphs.*

A not necessarily proper edge coloring of a graph yields a 'degree' at each vertex recording the number of incident edges for each color. Given a list of k -tuples we can ask if some k edge coloring of some graph from a list of possible host graphs has the given degree list. We will review some older (under different terminology) and some newer results about this sort of problem. (Received January 30, 2012)

1080-05-295 **Drew Armstrong*** (armstrong@math.miami.edu), Department of Mathematics, University of Miami, Coral Gables, FL 33146. *Rational Catalan Combinatorics.* Preliminary report.

For each positive rational number $\alpha/\beta \in \mathbb{Q}$ in lowest terms we define a Catalan number

$$\text{Cat}(\alpha/\beta) := \frac{1}{2\alpha + \beta} \binom{2\alpha + \beta}{\alpha}.$$

Note that the number $\text{Cat}(n/1) = \text{Cat}(n)$ is familiar. Everything you can do with $\text{Cat}(n)$ you can also do with $\text{Cat}(\alpha/\beta)$. In particular, I will discuss q 's and t 's. (Received January 30, 2012)

1080-05-300 **Yared Nigussie*** (nigussie@etsu.edu), Gilbreath Hall 308M, ETSU, Johnson City, TN 37604. *Finite structure for graph minor ideals of bounded tree-width.*

A graph H is a minor of another graph G , if H can be obtained from a subgraph of G by edge-contraction. A graph minor ideal I is a set of graph that is closed under the minor relation. That is, if G is in I and H is a minor of G , then H is in I . A celebrated theorem of Robertson and Seymour states that finite graphs are well-quasi-ordered (wqo) under the minor relation. The authors first prove this result for graphs of bounded tree-width. Although finite graphs are wqo by the minor relation, we ask if the graph minor ideals are wqo under the subset inclusion relation. The answer to this question is equivalent to showing that there is no Rado-type counterexample to the graph minor inclusion relation. In this talk, we will show that by finiding finite structure for the graph minor ideals (for the bounded tree-width case) we can give a positive answer. We will discuss how a recent result of finite structure for Friedman ideals of finite trees can be generalized for graph minor ideals of bounded tree-width. (Received January 30, 2012)

1080-05-305 **Alexandra Ovetsky Fradkin*** (aovetsky@gmail.com) and **Paul D. Seymour.** *The k edge-disjoint paths problem in digraphs with bounded independence number.*

In 1980, Fortune, Hopcroft, and Wyllie showed that the following algorithmic problem (k -EDP) is NP-complete with $k = 2$:

k Edge-Disjoint Paths (k -EDP)

Instance: A digraph G , and k pairs $(s_1, t_1), \dots, (s_k, t_k)$ of vertices of G .

Question: Do there exist directed paths P_1, \dots, P_k of G , mutually edge-disjoint, such that P_i is from s_i to t_i for $i = 1, \dots, k$?

In this talk we will present a polynomial time algorithm to solve k -EDP for fixed k in digraphs with bounded independence number. (Received January 30, 2012)

1080-05-310 **Jonah Blasiak*** (jblasiak@gmail.com). *Combinatorics of crystal bases for the Kronecker problem.*

The Kronecker coefficient $g_{\lambda\mu\nu}$ is the multiplicity of the $GL(V) \times GL(W)$ -irreducible $V_\lambda \otimes W_\mu$ in the restriction of the $GL(X)$ -irreducible X_ν via the natural map $GL(V) \times GL(W) \rightarrow GL(X)$, where $X = V \otimes W$. A difficult open problem in algebraic combinatorics is to find a positive combinatorial formula for these coefficients. Ketan Mulmuley, Milind Sohoni, and I recently gave an approach to this problem using crystal bases and an explicit description of the crystal basis in the $\dim V = \dim W = 2$ case. This talk will describe some of the combinatorics arising in this approach in the $\dim V = \dim W = 2$ case and the case that ν is a hook shape and $\dim W = 2$. Specifically, the Kronecker coefficient $g_{\lambda\mu\nu}$ is the number equivalence classes of certain pairs of tableaux of shapes (λ, μ) , with an equivalence relation similar to Knuth equivalence. (Received January 30, 2012)

1080-05-315 **Samuel K Hsiao***, Bard College, Mathematics Program, Annandale-on-Hudson, NY 12504. *Peaks and the cd-index.* Preliminary report.

The chain enumerative data of a convex polytope, and more generally a regular CW-sphere, is compactly represented by its cd-index. Though the cd-index is known to be non-negative for all regular CW-spheres, a general combinatorial interpretation has been elusive. We look at conditions under which the cd-index can be interpreted as enumerating peak sets and discuss the construction of spheres for which these conditions hold. (Received January 30, 2012)

1080-05-319 **Suil O*** (so@wm.edu), 407 Stratford Rd, D, Williamsburg, VA 23185, and **Gexin Yu.** *Path Cover Number in 4-regular Graphs.* Preliminary report.

A *path cover* of a graph is a set of disjoint paths so that every vertex in the graph is contained in one of the paths. The *path cover number* of graph G , denoted $p(G)$, is the minimum size of such a cover. We prove that if G is a 4-regular graph with n vertices, then $p(G) \leq \lceil \frac{n}{8} \rceil$. This result also confirms a Graffiti.pc Conjecture for 4-regular graphs. (Received January 31, 2012)

1080-05-325 **Daniel Slilaty***, Department of Mathematics and Statistics, Wright State University, Dayton, OH 45435, and **Thomas Zaslavsky.** *Strong-map images of graphic matroids.*

Consider a graph G and its cycle matroid $M(G)$. Any single-element coextension (and hence any elementary lift) of $M(G)$ defines a linear class of circuits of $M(G)$ and every linear class of circuits of $M(G)$ yields a single-element coextension. If $L(G, B)$ is the lift of $M(G)$ defined by the linear class of circuits B , then $L^*(G, B)$ is an elementary strong-map image of $M^*(G)$. The elementary lifts of $M(G)$ and their duals (the strong-map images of $M^*(G)$) have been in fairly widespread use in matroid theory for several decades. The strong-map images of $M(G)$ and their duals (the elementary lifts of $M^*(G)$) have been explored less. In this talk we will discuss strong-map images of $M(G)$ and give a combinatorial characterization of the elementary ones. (Received January 31, 2012)

1080-05-333 **Louis DeBiasio*** (debiasld@uohio.edu) and **Tao Jiang.** *Exact codegree condition for the Fano plane via digraphs.*

Let $\text{ex}_2(n, H)$ denote the maximum codegree of a 3-graph on n vertices which does not contain a copy of H . Mubayi proved that the codegree density of the Fano plane, \mathbf{F} , is $\frac{1}{2}$ and conjectured that the exact value is $\text{ex}_2(n, \mathbf{F}) = \lfloor \frac{n}{2} \rfloor$. Using a very sophisticated “quasi-randomness” argument, Keevash proved Mubayi’s conjecture. Here we give a simple proof of Mubayi’s conjecture by using an interesting class of 3-graphs that we call “rings” – which are obtained via an auxiliary digraph. We then determine the Turán density of this family of rings. (Received January 31, 2012)

1080-05-347 **Bruce Reed, Jonathan Noel and Hehui Wu*** (hehui.wu@mcgill.ca), 3480 University Street Montreal, School of Computer Science, McGill University, Montreal, QC H3A 0E9, Canada. *Some progress on Ohba’s Conjecture.* Preliminary report.

Given a set $L(v)$ on each vertex v of a graph G , we say G is L -choosable if G has a proper coloring such that each vertex v receives its color from $L(v)$. G is k -choosable if G is L -choosable whenever $L(v)$ has size at least k for each vertex v . The list chromatic number or choosability $ch(G)$ is the maximum k such that G is k -choosable. A graph is chromatic-choosable if its list chromatic number equals its chromatic number.

Ohba conjectured that a graph G is chromatic-choosable whenever it has chromatic number more than half of its vertex number. Let k be its chromatic number. We prove that Ohba's conjecture holds whenever it holds for complete k -partite graph, where the singleton parts all have the same list. We also reduce the case to that parts with size at most 4 have a simple fixed list structure. Base on these, we prove that Ohba's conjecture holds when there are few non-singleton parts. We also improve a result of Bruce and Sudakov, which states that if $|V(G)| \leq \frac{5}{3}\chi(G) - \frac{4}{3}$, then G is chromatic-choosable.

This is joint work with Bruce Reed and Jon Noel. (Received January 31, 2012)

1080-05-351 **Stephen G. Hartke*** (hartke@math.unl.edu), University of Nebraska–Lincoln, **Hong Liu**, University of Illinois at Urbana-Champaign, and **Sarka Petrickova**, University of West Bohemia. *On colorings of fractional powers of graphs*. Preliminary report.

For any $n \geq 0$, the n -subdivision of a graph G is the graph $G^{1/n}$ formed from G by replacing each edge with a path of length n . For any $m \geq 0$, the m th power of G is the simple graph G^m with the same vertex set as G and where two vertices are adjacent in G^m if the distance between them in G is at most m . For $m < n$, the fractional power $G^{m/n}$ of G is the m th power of $G^{1/n}$. Motivated by the Total Coloring Conjecture of Vizing and Behzad, Iradmusa proposed the question of determining the chromatic numbers of fractional powers in terms of their clique numbers. He conjectured that $\chi(G^{m/n}) = \omega(G^{m/n})$ when G is a connected graph with $\Delta(G) \geq 3$ and $m < n$. We prove the conjecture in many cases, such as when $\Delta(G) \geq 4$ and m is even. We also give a counterexample to the conjecture with maximum degree 3. (Received January 31, 2012)

1080-05-352 **Svetlana Poznanovikj*** (svetlana@math.gatech.edu), Georgia Institute of Technology, School of Mathematics, 686 Cherry Street 686, Atlanta, GA 30332. *Sorting index and cycles for permutations and matchings*.

We define cycles and sorting index for matchings in a way that generalizes the number of cycles and the sorting index for permutations. Using a bijection with weighted Dyck paths we show that this pair of combinatorial statistics has the same distribution as a pair of statistics on matchings defined in terms of nestings. This in turn allows us to refine known results about permutations. (Received January 31, 2012)

1080-05-354 **Antoine Julien*** (antoinej@uvic.ca), University of Victoria, Dept of Math and Stat, PO BOX 3060 STN CSC, Victoria, BC V8W 3R4, Canada. *Metric considerations on the tiling space*.

A tiling space can be endowed with a usual distance. This distance is related with the complexity function: counting patches of a given size in a tiling is the same as counting neighbourhoods of a certain diameter in the transversal of the tiling space. The exponent of the complexity function (when it exists) is then the fractal dimension of the transversal.

Representing tiling transversals by Bratteli diagrams with weights gives an efficient way to count neighbourhoods. As an application, this gives a self-sustained proof of a known fact: self-similar tilings of dimension d with finite local complexity have complexity growing like n^d . Also, substitution tiling transversals can be embedded in an Euclidean space, by a map which is a bi-Lipschitz homeomorphism onto its image.

Some of the results that I will present were obtained in collaboration with Jean Savinien and Jean Bellissard. (Received January 31, 2012)

1080-05-356 **Carolyn Chun** (chchchun@gmail.com), Wellington, New Zealand, **Dillon Mayhew** (dillon.mayhew@msor.vuw.ac.nz), Wellington, New Zealand, and **Mike Newman*** (mnewman@uottawa.ca), Ottawa, Canada. *On sixth-root-of-unity matroids*. Preliminary report.

We are motivated by the desire to have a “nice” decomposition theorem for the strictly sixth-root-of-unity matroids, namely those that are representable over $\text{GF}(3)$, $\text{GF}(4)$ but not $\text{GF}(5)$. Perhaps the nicest interpretation of the word “nice” would be along the lines of Seymour's decomposition theorem for regular matroids: we would have a finite number of natural classes and a finite number of sporadic matroids as building blocks, and we can glue these together using 1-sums, 2-sums or 3-sums.

Regular matroids would be one of the natural classes. It was at one time thought that the only sporadic matroid was $\text{AG}(2,3) \setminus e$. This is known not to be the only sporadic matroid, and in this talk we further give an infinite family of sporadic matroids.

Specifically, we will say (for the purposes of this abstract) that a matroid is indecomposable if it is strictly sixth-root-of-unity, is 3-connected, and if X, Y is a 3-separation then either $\min\{r(X), r(Y)\} \leq 2$ or $\min\{r^*(X), r^*(Y)\} \leq 2$. We give an infinite family of indecomposable non-regular matroids. Much of our proof

is not limited to sixth-root-of-unity, and, in principle at least, could be applied to other classes. (Received January 31, 2012)

1080-05-363 **Thomas Zaslavsky*** (zaslav@math.binghamton.edu), Dept. of Mathematical Sciences, Binghamton University (SUNY), Binghamton, NY 13902-6000. *Complementary matroid Whitney numbers*. Preliminary report.

Whitney numbers of complementary submatroids of a fixed matroid obey supermodular inequalities. This was first noticed by Pitteloud (2004) for the matroids of complementary subgraphs of the complete graph. (Received January 31, 2012)

1080-05-364 **Marcelo Aguiar, Carlos Andre, Carolina Benedetti, Nantel Bergeron, Zhi Chen, Persi Diaconis, Anders Hendrickson, Samuel Hsiao and Huilan Li*** (huilan.li@gmail.com). *Hopf algebras, supercharacters and symmetric functions in noncommuting variables*.

The Hopf algebra of symmetric functions in noncommuting variables is isomorphic to the Hopf algebra of supercharacters of uni-uppertriangular matrices with entries in the finite field \mathbb{F}_2 . This result is an analogue of the following well-known fact: there is a characteristic map from the space of class functions on symmetric groups to the algebra of symmetric functions (in commuting variables). (This is a joint work with 27 people but for limited space I only can list 9 of us. The paper is available at <http://arxiv.org/abs/1009.4134>) (Received January 31, 2012)

1080-05-374 **Linyuan Lu and Kevin G Milans*** (milans@math.sc.edu). *Turán and Ramsey Problems for Complete Set Systems*. Preliminary report.

In the n -dimensional Boolean lattice $2^{[n]}$, a d -dimensional *complete set system* is a collection of 2^d sets that is an affine subspace (when viewed as vectors) and induces a copy of $2^{[d]}$ (when viewed as a subposet of $2^{[n]}$). We obtain bounds on the maximum size of a family of sets in $2^{[n]}$ that does not contain a d -dimensional complete set system. We also consider the corresponding Ramsey problem and obtain a complete set system analogue of the Canonical Ramsey Theorem of Erdős and Rado. This is joint work with Linyuan Lu. (Received January 31, 2012)

1080-05-380 **D. Christopher Stephens*** (chris.stephens@mtsu.edu). *Knots and torus graphs*. We discuss knots in graphs embedded in the torus. (Received January 31, 2012)

06 ► Order, lattices, ordered algebraic structures

1080-06-316 **Valentina Harizanov*** (harizanov@gwu.edu), Department of Mathematics, Washington, DC 20052. *Different approaches to orders on groups*.

A group is left-orderable if there is a linear ordering of its domain, which is left-invariant with respect to the group operation. If the ordering is also right-invariant with respect to the operation, then the group is bi-orderable. Orderable groups have been studied since Dedekind, Hölder and Hilbert, and are of great importance in algebra. In the last decade, the theory of orders on groups has become an important tool in low-dimensional topology, in particular, in understanding the geometric properties of 3-dimensional manifolds. Orders on countable groups have also been studied in computability theory, both for abelian and non-abelian groups. Left-orderable groups have been recently studied by using dynamical methods. There is a natural topology on the set of all left orders, as well as bi-orders, on a particular structure, and these spaces are compact even when the structure is only a magma. We will investigate how algebraic, topological, and computability theoretic properties of the spaces of orders interact. (Received January 31, 2012)

11 ► Number theory

1080-11-8 **Yinghui Wang*** (yw2450@columbia.edu), Columbia University, Department of Mathematics, Room 509, MC 4406, 2990 Broadway, New York, NY 10027, and **Steven J Miller** (Steven.J.Miller@williams.edu), 202 Bronfman Science Center, Williams College, Williamstown, MA 01267. *Distribution of Summands in Generalized Zeckendorf Decompositions, II*.

Every positive integer has a unique representation as a sum of non-adjacent Fibonacci numbers F_n . While the average number of summands for integers in $[F_n, F_{n+1})$ has been known since the 1950s, the proofs involved

number theory and continued fractions, and were limited to results on the mean. Using a combinatorial vantage, we prove the fluctuations about the mean become normally distributed as n tends to infinity. The proof involve generating functions, differentiating identities and the method of moments, and extend to a wide-class of generalized Zeckendorf decompositions arising from certain linear recurrence relations. (Received September 14, 2011)

1080-11-60 **Vijayarangan Natarajan*** (n.vijayarangan@tcs.com), Tata Consultancy Services Ltd (TCS), TCS Innovation Labs, NO. 17, Cathedral Road, Chennai, 600086, India. *A new approach on implementing the Elliptic Curve Scalar Multiplication method in Cryptography*. Preliminary report.

Elliptic Curve Cryptography (ECC) is based on an entirely different problem in Number theory, called the "discrete logarithm problem". Here the task is to find what power of a given number will satisfy a "modularity" constraint. Since an algorithm based on ECC uses much smaller key lengths, it is considered an alternative mechanism to RSA, both in security per bit of key length, and in storage requirements. It is known that an important core operation in the elliptic curves is scalar multiplication. For the last couple of years, many methods have been proposed to reduce the computational complexity of EC scalar multiplications. For elliptic curves, a Double Base Number System (DBNS) representation using 2 and 3 as bases has been efficient. The research work shows that there has been no uniformity to express a number in DBNS. Therefore, our invention shows to express a DBNS in decreasing order. This method is used to calculate EC scalar multiplication over a finite elliptic curve. In order to achieve this, new algorithms have been designed and implemented for DBNS and EC scalar multiplication. These algorithms perform on any elliptic curve over a prime / binary field. The benefits of this new work are reduced computational complexity and increased speed. (Received December 29, 2011)

1080-11-131 **Alexandra Shlapentokh*** (shlapentokha@ecu.edu), Department of Mathematics, East Carolina University, Greenville, NC 27858. *First-order and Diophantine Undecidability over function fields of positive characteristic*. Preliminary report.

We give a brief survey of the existing results concerning first-order and Diophantine undecidability over function fields of positive characteristic, concentrating on the recent progress in extending results of Kim and Roush. (Received January 20, 2012)

1080-11-340 **Eva Curry*** (eva.curry@acadiau.ca), Department of Mathematics and Statistics, Acadia University, 12 University Ave, Wolfville, NS B4P 2S3, Canada. *Pseudodigits and orbits of ergodic transformations related to radix representations*.

This talk will look at pointwise rather than measure-theoretic results related to ergodic transformations arising from radix representations. Included will be results on pseudodigits, or periodic orbits for points not representable by a radix representation. (Received January 31, 2012)

15 ► *Linear and multilinear algebra; matrix theory*

1080-15-151 **Cherng-tiao Perng*** (ctperng@nsu.edu), 700 Park Avenue, Norfolk State University, Department of Mathematics, Norfolk, VA. *A Note on Farkas's Lemma And Related Theorems*.

In this note we prove that the following results are equivalent: Farkas's Lemma, Variant of Farkas's Lemma, Gale's Theorem, Gordan's Theorem, and three versions of the Separating Hyperplane Theorem, in the sense that they are related by simple linear algebraic arguments. Furthermore, we prove Farkas's Lemma by a geometric argument (when the vector spaces in question are over the field of real numbers), and Gordan's Theorem by an algebraic argument, therefore this note is self-contained. As an application, we mention in the final section that Stiemke's Theorem is a special case of Separation I. Note that Stiemke's Theorem is known also as the Fundamental Theorem of Asset Pricing when formulated in the language of financial mathematics. We remark that except for the geometric proof, our proof made all the above results valid for vector spaces over any ordered (possibly skew) field, and we did this by elementary linear algebra arguments without using linear programming. (Received January 22, 2012)

1080-15-296 **M S Copenhaver, Y Kim*** (kim4y@cmich.edu), **C Logan, K Mayfield, S K Narayan** and **J Sheperd**. *Diagram vectors and Tight Frame Scaling in Finite Dimensions*.

We consider frames in a finite-dimensional Hilbert space \mathcal{H}_n where frames are exactly the spanning sets of the vector space. We generalize the notion of diagram vectors in \mathbb{R}^n and \mathbb{C}^n and provide a characterization of when a unit-norm frame in \mathbb{R}^n can be scaled to a tight frame. (Received January 30, 2012)

1080-15-312 **Jerzy Kocik*** (jkocik@siu.edu), Department of Mathematics, Southern Illinois University, Carbondale, IL 62901. *Classical and quantum aspects of Krawtchouk matrices*.

Although originally motivated by statistical applications, Krawtchouk polynomials, especially in their matrix form, have a more universal nature. We will present their classical and quantum aspects and will hint towards a combinatorial topological interpretation. (Received January 30, 2012)

16 ► Associative rings and algebras

1080-16-17 **John S. Kauta*** (john.kauta@ubd.edu.bn), Department of Mathematics, Faculty of Science, University of Brunei, Bandar Seri Begawan, BE 1410, Brunei. *On a class of semihereditary crossed-product orders*.

Let F be a field, let V be a valuation ring of F of arbitrary Krull dimension (rank), let K be a finite Galois extension of F with group G , and let S be the integral closure of V in K . Let $f : G \times G \mapsto K \setminus \{0\}$ be a normalized two-cocycle such that $f(G \times G) \subseteq S \setminus \{0\}$, but we do not require that f should take values in the group of multiplicative units of S . One can construct a crossed-product V -algebra $A_f = \sum_{\sigma \in G} Sx_\sigma$ in a natural way, which is a V -order in the crossed-product F -algebra $(K/F, G, f)$. If V is unramified and defectless in K , we show that A_f is semihereditary if and only if $f(\sigma, \tau) \notin M^2$ for all $\sigma, \tau \in G$, and every maximal ideal M of S . If in addition $J(V)$ is not a principal ideal of V , then A_f is semihereditary if and only if it is an Azumaya algebra over V .

Keywords: Crossed-product orders, Semihereditary orders, Azumaya algebras, Dubrovin valuation rings. (Received October 18, 2011)

1080-16-192 **Garrett Johnson*** (gwjohns3@ncsu.edu). *The Rational Cherednik Algebras of type $G(m, 1, 2)$ and Solutions to the Classical Yang-Baxter Equation*. Preliminary report.

Let H denote the rational Cherednik algebra associated to the reflection group of type $G(m, 1, 2)$. We will use the polynomial representation $k[x_1, x_2]$ of H to demonstrate how certain elements in H (viewed as endomorphisms of the vector space $k[x_1, x_2] \cong k[x] \otimes k[x]$) yield solutions to the classical Yang-Baxter equation. We give some examples that arise from this construction, such as the generalized Cremmer-Gervais r -matrices. Next, we will describe how these r -matrices relate to a conjecture of Gerstenhaber and Giaquinto concerning boundary solutions to the CYBE. (Received January 26, 2012)

18 ► Category theory; homological algebra

1080-18-375 **Krzysztof K Putyra*** (putyra@math.columbia.edu), Columbia University, Department of Mathematics, 2990 Broadway, Room 509 MC 4406, New York, NY 10027, and **Jozef H Przytycki**. *Mayer-Vietoris sequence for homology of multispindles*.

A Mayer-Vietoris sequence is a powerful tool to compute homology groups of topological spaces. A similar exact sequence arises in a theory of distributive homology. Precisely, for any multispindle X , that is a set with a bunch of operations \star_1, \dots, \star_k that are idempotent, self- and mutually distributive, one can relate its distributive homology with homology groups of orbits $X \star_1 x, \dots, X \star_k x$ for any $x \in X$. In particular, we can compute distributive homology for any finite distributive lattice.

In my talk I will describe the construction of distributive homology and state the Mayer-Vietoris sequence with a few consequences. If time permits, I will present a few steps of the proof. (Received January 31, 2012)

1080-18-383 **Zbigniew Oziewicz*** (oziewicz@unam.mx), Universidad Nacional Autonoma de Mexico, Facultad de Estudios Superiores Cuautitlan, C.P. 54714 Cuautitlan Izcalli, Cuautitlan Izcalli, Mexico, Mexico. *Clifford algebra is Frobenius algebra - in one way only?*

In 1894 Elie Cartan in his Thèse introduced what is baptized as Killing trace form for Lie algebra, and we refer to this form/scalar-product as to Cartan-Killing tensor. We demonstrate that Cartan-Killing tensor for Clifford algebra is Frobenius, and also a bialgebra structure for some Clifford algebra. For an associative and unital k -algebra Y , Frobenius scalar-product is equivalent to Frobenius form $\in \text{module}(Y, k)$. A form ε such that

$\varepsilon(e) \neq 0$ for some homogeneous non-zero $e \in Cl$ with $grade\ e \neq 0$ is said to be exotic. Clifford algebra Cl possesses $(\dim Cl)$ -dimensional manifold of Frobenius exotic forms. We conclude that Frobenius exotic Cl -forms have no impact on applications, and a choice of Frobenius exotic Cl -form it is hard to interpret.

The aim of this talk is to introduce Frobenius Cl -forms, review various equivalent definitions, look at a manifold of Grassmann and Clifford co-algebras defined as graphical camels, and illustrate on examples of Clifford algebra of one- and two-dimensional vector spaces. (Received January 31, 2012)

20 ► *Group theory and generalizations*

1080-20-274 **Piotr Stachura*** (stachura@fuw.edu.pl). *The κ -Poincare Group on the C^* -algebra level.* Preliminary report.

The κ deformation of the Poincare Group has been known since nineties. However, it exists on the formal deformation level. We present its C^* -version and show it is built by the twist. The language of groupoids and its C^* -algebras is used. (Received January 30, 2012)

30 ► *Functions of a complex variable*

1080-30-71 **Tao Chen***, 365 Fifth Avenue, New York, NY 10016, **Yunping Jiang** (yunping.jiang@qc.cuny.edu), 65-30 Kissena Blvd., Flushing, 11367, and **Linda Keen** (linda.keen@lehman.cuny.edu), 250 Bedford Pk. Blvd., Bronx, NY 10468. *Bounded Geometry and Families of Meromorphic Functions.*

In 1986 Thurston gave a topological characterization of when it is possible to realize, by combinatorial equivalence, a given finite-degree branched covering map of the sphere with finite postcritical set as rational map. The finiteness of the degree was crucial to his proof. Recently, Hubbard, Schleicher and Shishikura extended his theorem to the family of exponential maps. In joint work with Yunping Jiang and Linda Keen, we prove an analog of Thurston's theorem for more general infinite-degree covering maps with certain finiteness properties. We give an analytic condition called "bounded geometry" that characterizes when such a map can be realized by an entire or meromorphic function. In this talk, we will explain our theorem for the family of meromorphic functions with two asymptotic values and no critical points. (Received January 07, 2012)

1080-30-232 **Zhe Wang*** (wangzhecuny@gmail.com), 9217 52 Avenue, Elmhurst, NY 11373, and **Sudeb Mitra** and **Yunping Jiang**. *Holomorphic motion and Quasiconformal motion on the Riemann Sphere.*

I will talk about Slodkowski's extension theorem of holomorphic motion and our extension result of quasiconformal motion. The Teichmuller space of a closed set in the Riemann sphere will be also discussed in this talk. (Received January 28, 2012)

32 ► *Several complex variables and analytic spaces*

1080-32-46 **Maher M.H. Marzuq*** (maher_marzuq@yahoo.com), German Jordanian University, Department of Water Engineering and Managemen, PO Box 35247, Amman, 11180, Jordan. *A Note on Convergence in Bergman Spaces over Bounded Symmetric Domains and.*

In this paper we prove a result that generalizes the result of Stoll [7] on the unit disk to bounded star-shaped circular domains. (Received December 16, 2011)

1080-32-239 **Marshall A. Whittlesey*** (mwhittle@csusm.edu), Department of Mathematics, California State Univeristy San Marcos, San Marcos, CA 92078. *Solutions to Riemann-Hilbert boundary value problems on the ball.* Preliminary report.

Let B_2 be the open unit ball in C^2 and let X_z be a smoothly bounded compact set in C^n for $z \in \partial B_2$. We discuss how to find an analytic $f : B_2 \rightarrow C^n$ extending smoothly to ∂B_2 such that $f(z) \in X_z$ for all $z \in \partial B_2$. (Received January 28, 2012)

33 ► *Special functions*

1080-33-321 **Ranjan Kumar Jana*** (rkjana2003@yahoo.com, rkj@ashd.svnit.ac.in), Department of Applied Mathematics, S. V. National Institute of Technology, Surat, Gujarat 395 007, India, **Ibrahim A. Salehbbhai** (ibrahimmaths@gmail.com), Department of Applied Mathematics, S. V. National Institute of Technology, Surat, Gujarat 395 007, India, and **Ajay Kumar Shukla** (ajayshukla2@rediffmail.com, aks@ashd.svnit.ac.in), Department of Applied Mathematics, S. V. National Institute of Technology, Surat, Gujarat 395 007, India. *Shivley's Polynomials of Two Variables*. Preliminary report.

Shivley [On pseudo Laguerre Polynomials, Michigan Thesis, 1953] discussed a family of Laguerre Polynomials and reported in his thesis. In this present talk we introduced Shivley's Polynomials of two variables. The Generating Functions and Operational Representations of these new polynomials are also obtained. Some special cases of the established results are also deduced as corollaries. (Received January 31, 2012)

34 ► *Ordinary differential equations*

1080-34-133 **Ronald E. Mickens*** (rohms@math.gatech.edu), Box 1744 - Physics Department, Atlanta, GA 30314. *Analysis of a NSFD Scheme for an Oscillator Having Fractional Damping*.

A finite difference discretization is constructed for a linear harmonic oscillator having nonlinear damping:

$$\ddot{x} + x = -\epsilon(\dot{x})^{1/3}. \quad (*)$$

Note that the form selected for the dissipative term is proportional to the one-third power of the velocity, i.e., the first-derivative of the dependent variable. After an investigation is made of the original ODE, we present results on the corresponding NSFD scheme [1]

$$\frac{x_{k+1} - 2x_k + x_{k-1}}{4 \left[\sin\left(\frac{h}{2}\right) \right]^2} + x_k = -\epsilon \left[\frac{x_k - x_{k-1}}{2 \sin\left(\frac{h}{2}\right)} \right]^{1/3}, \quad (**)$$

where h is the step-size. In particular, we examine whether the solutions to (*) and (**) are dynamical consistent with respect to the number of oscillations which take place before the amplitude of the oscillations go to zero. The techniques used in our analysis include geometrical phase-space procedures, numerical integration, and a discrete version of the perturbative method of slowly varying amplitude and phase [2].

[1] R. E. Mickens, *Nonstandard Finite Difference Models of Differential Equations* (World Scientific, 1994).

[2] R. E. Mickens, *J. Franklin Institute* **324**, 263 (1987). (Received January 20, 2012)

1080-34-344 **Maila Capuno Brucal Hallare*** (mbrucal@math.ku.edu), 405 Snow Hall, Jayhawk Blvd, Department of Mathematics, University of Kansas, Lawrence, KS 66045. *Solutions of Spatially-Discrete Differential Equations over an Inhomogeneous Medium*.

We study entire solutions of a one-dimensional lattice differential equation over an inhomogeneous medium,

$$\dot{u}_j = d_j(u_{j-1} - u_j) + d_{j+1}(u_{j+1} - u_j) - u_j(u_j - a)(u_j - 1), \quad \text{for } j \in \mathbb{Z}, t \in \mathbb{R}$$

where the coefficients $d_j > 0$ are positive and can be either viewed as a diffusion or a coupling parameter of neighboring solutions $u_j(t)$ and $a \in (0, 1)$ is a detuning parameter of the smooth cubic nonlinearity term. Here, entire solutions are solutions that are defined for all $j \in \mathbb{Z}$ and $t \in \mathbb{R}$. Assuming that the equation has traveling front solutions when $d_j = d$ for some sufficiently large positive number d , we look at the existence of entire solutions which behave as two fronts coming from both sides of the j -axis. Our main tool is a comparison principle argument by constructing appropriate super- and sub- solutions that characterize the asymptotic behavior of solutions as $t \rightarrow -\infty$. (Received January 31, 2012)

35 ► *Partial differential equations*

1080-35-1 **Gunther Uhlmann***, Department of Mathematics, C-449 Padelford Hall, Box 354350, Seattle, Washington 98195. *Cloaking: science meets science-fiction*.

Can one make objects invisible? This has been a subject of human fascination for millennia in Greek mythology, movies, science fiction etc including the legend of Perseus versus Medusa and the more recent The Invisible Man, The Invisible Woman, Star Trek and Harry Potter, among many others. In the last decade or so there has been several scientific proposals to achieve invisibility. We will introduce some of these in a non-technical fashion concentrating in the so-called "transformation optics" that have received the most attention in the scientific

literature. The advent of “metamaterials”, that is materials that have properties usually not found in nature, has been made possible to make experimental progress in achieving cloaking. We will also describe some of this progress in the lecture.

(Received March 25, 2011)

1080-35-29 **jun zhou*** (jzhou@swu.edu.cn), Williamsburg, VA. *QUALITATIVE ANALYSIS OF A STRONGLY COUPLED PREDATOR-PREY SYSTEM WITH MODIFIED HOLLING-TANNER FUNCTIONAL RESPONSE.*

In this paper, we deal with the following strong coupled predator-prey model with modified Holling-Tanner functional response under homogeneous Neumann boundary conditions

$$\begin{cases} u_t - d_1 \Delta u = ru(1-u) - \frac{\beta uv}{u+mv} & \text{in } \emptyset \times \mathbb{R}_+, \\ v_t - d_2 \Delta \left[\left(1 + \frac{d_3}{1+\alpha u} \right) v \right] = v \left(b - \frac{v}{u} \right) & \text{in } \emptyset \times \mathbb{R}_+, \end{cases} \quad (\text{P})$$

and its corresponding steady states, where $\Omega \subset \mathbb{R}^N$ ($N \geq 1$) is smooth bounded domain, $\mathbb{R}_+ = (0, \infty)$, $d_1, d_2, \alpha, \beta, r, b, m$ are positive constants and d_3 is a nonnegative constant. We main discuss the following two problems: (1) stability of the positive constant solution of (P) with $d_3 = 0$; (2) existence and non-existence results about the non-constant positive solutions of the corresponding steady-states of (P). (Received December 03, 2011)

1080-35-51 **Justin Holmer and Leila Setayeshgar*** (leila_setayeshgar@brown.edu), Division of Applied Mathematics, Brown University, 182 George St., Providence, RI 02912. *Exact Dynamics of Solitons for mKdV with Multiplicative White Noise.*

We study the dynamics of soliton solutions to the mKdV in the presence of a multiplicative white noise, $du = \partial_x(-\partial_x^2 u - 2u^3)dt + \epsilon u dW$, where $0 < \epsilon \ll 1$, u is a random process defined on $(t, x) \in \mathbb{R}^+ \times \mathbb{R}$, and W is a Wiener process on $L^2(\mathbb{R})$. We show (via symplectic considerations) that the solutions remain $O(\epsilon^{4/3})$ close to the soliton manifold on an $O(\epsilon^{-2/3})$ time scale and thus, derive a *nearly exact* equation for the evolution of the solution. (Received December 23, 2011)

1080-35-54 **Dipendra Regmi*** (dregmi@math.okstate.edu), 401 MSCS, Oklahoma State University, Stillwater, OK 74078. *The 2D MHD equations with horizontal dissipation and horizontal magnetic diffusion.*

We study the global regularity issue for the 2D incompressible MHD equations with horizontal dissipation and horizontal magnetic diffusion. We establish a global bound for the L^q -norms of the horizontal components of the velocity and of magnetic field for any $2 \leq q < \infty$. A global L^2 -bound for the pressure is also obtained. In addition, we also establish a conditioned global regularity. This is a joint work with Chongsheng Cao and Jiahong Wu. (Received December 25, 2011)

1080-35-58 **Ming Chen, Jeremy L Marzuola*** (marzuola@math.unc.edu), **Daniel Spirn and J Douglas Wright.** *C^3 ill-posedness of the gravity-capillary equations.*

We prove via explicitly constructed initial data that solutions to the gravity-capillary wave system in \mathbb{R}^3 representing a 2d air-water interface immediately fail to be C^3 with respect to the initial data if the initial data $(h_0, \psi_0) \in H^{s+\frac{1}{2}} \otimes H^s$ for $s < 3$. Similar results hold in \mathbb{R}^2 domains with a 1d interface. Furthermore, we discuss the illposedness threshold for the pure gravity water wave system. (Received December 28, 2011)

1080-35-82 **rana parshad*** (rana.parshad@kaust.edu.sa), thuwal, western 23955, Saudi Arabia, and **aslan kasimov and ranjit upadhyay.** *Long time dynamics of a diffusive three species food chain model.*

We consider the well known Upadhyay-Rai three species food chain model, with the inclusion of spatial spread. This model has immense applications in modeling realistic food chains, in tritrophic food environments. we demonstrate the existence of a global attractor for the system which is compact in $L^2(\Omega)$ and attracts all bounded sets in the $L^2(\Omega)$ topology. This is done via a novel Kuratowski measure decomposition technique. The system supports rich dynamics, including Turing instability and chaos. We further demonstrate the Turing instability and pattern formation, via numerical simulations. (Received January 11, 2012)

1080-35-98 **Matthew D Blair*** (blair@math.unm.edu), Department of Mathematics and Statistics, MSC01 1115, 1 University of New Mexico, Albuquerque, NM 87110. *On Strichartz and local smoothing estimates in exterior domains.*

We consider Strichartz estimates for the Schrödinger equation in exterior domains, a family of space time integrability estimates which rely on the dispersive effects of the solution map. While such estimates are reasonably well understood in Euclidean space, less is known about how the imposition of boundary conditions impact the validity of these estimates. We will review positive results in this area, including a joint work with H. Smith and C. Sogge. Furthermore, for strictly concave domains, we will examine the role of a family of refined local smoothing estimates in establishing these inequalities. (Received January 15, 2012)

1080-35-99 **M N Grillakis** and **M Machedon***, mxm@math.umd.edu, and **D Margetis**. *Second order corrections to mean field evolution of weakly interacting bosons.*

One starts with initial conditions of the form $\phi(x_1)\phi(x_2)\cdots\phi(x_N)$ and evolves these according the linear N-body Schrödinger equation with weak pair interactions. The goal is to show that, in an approximate sense, the solution looks like $\phi(t, x_1)\phi(t, x_2)\cdots\phi(t, x_N)$ in a suitable sense, to be made precise, where ϕ satisfies the cubic NLS and $N \rightarrow \infty$. I will review the results of Erdős, Schlein and Yau, and discuss a different approach and results obtained in joint work with M. Grillakis and D. Margetis. (Received January 15, 2012)

1080-35-107 **Mimi Dai*** (mdai@slugmail.ucsc.edu), **Jie Qing** and **Maria Schonbek**. *Asymptotic Behavior of Solutions to the Liquid Crystal Systems in \mathbb{R}^3 .*

In this paper we study the asymptotic behavior for solutions to a nematic liquid crystals system in the whole space \mathbb{R}^3 . The fluid under consideration has constant density and small initial data. The main ingredient to derive decay is Fourier splitting method which was originally introduced by M. Schonbek to study the large time behavior of solutions to Navier-Stokes equations. The asymptotic behavior of solutions to systems of nematic liquid crystals, on bounded domains with constant fluid density has been studied by several other authors using different methods. (Received January 17, 2012)

1080-35-112 **Jason Metcalfe*** (metcalfe@email.unc.edu), Department of Mathematics, University of North Carolina, Chapel Hill, NC 27514. *Local well-posedness for quasilinear Schrodinger equations.*

We will discuss ongoing joint work with J. Marzuola and D. Tataru concerning low regularity local well-posedness results for quasilinear Schrodinger equations. Our results establish new benchmarks in terms of the required regularity for such equations to be well-posed. The function spaces in which we work incorporate a summability over cubes in order to deal with issues arising from the Mizohata integrability condition / the infinite speed of propagation. (Received January 18, 2012)

1080-35-116 **Luiz Gustavo Farah*** (lgfarah@gmail.com) and **Ademir Pastor** (apastor@ime.unicamp.br). *On well-posedness and wave operator for the gKdV equation.*

We consider the generalized Korteweg-de Vries (gKdV) equation $\partial_t u + \partial_x^3 u + \mu \partial_x(u^{k+1}) = 0$, where $k > 4$ is an integer number and $\mu = \pm 1$. We give an alternative proof of the Kenig, Ponce and Vega result, which asserts local and global well-posedness in $\dot{H}^{s_k}(\mathbb{R})$, with $s_k = (k-4)/2k$. A blow up alternative in suitable Strichartz-type spaces is also established. The main tool is a new linear estimate. As a consequence, we also construct a wave operator in the critical space $\dot{H}^{s_k}(\mathbb{R})$, extending the results of Côte. (Received January 18, 2012)

1080-35-117 **Cristi D. Guevara*** (crisdarley@gmail.com), 593 S Buena Vista ct, Gilbert, AZ 85296. *Global Behavior of Finite Energy Solutions to The d-dimensional Focusing Nonlinear Schrödinger Equation.*

We study the global behavior of finite energy solutions to the d -dimensional focusing NLS equation, $i\partial_t u + \Delta u + \|u\|^{p-1}u = 0$, with initial data $u_0 \in H^1$, $x \in \{R\}^d$; the nonlinearity power p and the dimension d are chosen so that the scaling index $s = \frac{d}{4}2 - \frac{2}{p} - 1$ is between 0 and 1, thus, the NLS is mass-supercritical ($s > 0$) and energy-subcritical ($s < 1$).

For solutions with $\{ME\}[u_0] < 1$ (here $\{ME\}[u_0]$ stands for an invariant and conserved quantity given in terms of the mass and energy of u_0), we give a sharp threshold for scattering and blowup. We also discuss an application of the concentration-compactness to the existence of a “weak” blowup solutions for infinite-variance initial data. We also discuss an application of the concentration-compactness to the existence of a weak blowup solutions for the infinite-variance initial data. (Received January 18, 2012)

1080-35-118 **Thomas Wanner*** (twanner@gmu.edu), Dept of Mathematical Sciences, MS 3F2, George Mason University, 4400 University Drive, Fairfax, VA 22030. *Stochastic Nucleation Dynamics.*

Stochastic Cahn-Morral systems serve as basic models for several phase separation phenomena in multi-component metal alloys. In this talk, I will discuss dynamical aspects of a certain type of phase separation – known as homogeneous nucleation – in which the material separates into small droplets. In addition to a description of the theoretical background, numerical studies will be presented in the context of alloys consisting of three metallic components which give a statistical classification for the distribution of droplet types as the component structure of the alloy is varied. We relate these statistics to the equilibrium structure of the deterministic Cahn-Morral system and show that even highly unstable equilibria can be observed during the nucleation process, and in fact serve as organizing centers for the dynamics. (Received January 19, 2012)

1080-35-125 **Fengqi Yi*** (fengqi.yi@gmail.com), Harbin, Heilongjia 150001, Peoples Rep of China, **Eamonn A Gaffney** (Eamonn.Gaffney@maths.ox.ac.uk), Oxford, OX1 3LB, England, and **Seirin Lee** and **Philip K Maini**. *Pattern formation induced by delay and diffusion in a delayed reaction-diffusion Schnakenberg System.* Preliminary report.

A delayed reaction-diffusion Schnakenberg system with gene expression time delay for reversible ligand binding subject to the Neumann boundary conditions is considered. We perform a detailed stability and Hopf bifurcation analysis to the system, and derive conditions for determining the direction of bifurcation and the stability of the bifurcating periodic solution. Delay-diffusion driven instability of the unique constant equilibrium solution and the diffusion-driven instability of the spatially homogeneous periodic solution are investigated. Numerical simulations are included in the paper to support our theoretical analysis. This is a joint work with Eamonn Gaffney(Oxford), Seirin Lee(RIKEN) and Philip Maini(Oxford). (Received January 20, 2012)

1080-35-136 **Pengfei Guan** and **Junfang Li*** (jfli@uab.edu), 452 Campbell Hall, Birmingham, AL 35294. *A new mean curvature type of hypersurface flow.* Preliminary report.

In this talk, we will present a new type of mean curvature flow. For any closed star-shaped smooth hypersurface, this flow exists for all time $t > 0$ and exponentially converges to a round sphere. Moreover, we will show that all the quermassintegrals evolve monotonically along this flow. Consequently, we prove a class of isoperimetric type of inequalities including the classical isoperimetric inequality on star-shaped domains. (Received January 21, 2012)

1080-35-145 **I Bejenaru*** (bejenaru@math.uchicago.edu), Chicago, IL 60637, and **A Ionescu**, **C Kenig** and **D Tataru**. *Equivariant Schroedinger Maps in 2D with large data.*

I will talk about the global regularity of equivariant maps in two dimensions with large data. (Received January 22, 2012)

1080-35-170 **Xuwen Chen*** (chenxuwen@math.umd.edu), Department of Mathematics, University of Maryland, College Park, MD 20742. *The Rigorous Derivation of the 2d Cubic NLS with Anisotropic Switchable Quadratic Traps.*

In this talk, we will explain how the nonlinear Schroedinger equations arises from an experimentally observed phenomenon called Bose-Einstein condensation. We will also present a rigorous derivation of the 2d cubic nonlinear Schroedinger equation with anisotropic switchable quadratic traps from a N-body linear Schroedinger equation. (Received January 25, 2012)

1080-35-171 **Necibe Tuncer***, necibe-tuncer@utulsa.edu. *Radially Projected Finite Elements for Pattern Formation on Spheroidal Surfaces.*

We develop and analyze a new numerical method to approximate solutions of reaction diffusion systems defined on arbitrary surfaces. In particular, we are interested in reaction diffusion systems that model pattern formation on evolving surfaces. Such systems have numerous applications; examples include patterns on seashells and tropical fish, tumor growth and cell membrane deformation. The method we propose is based on *radially projected finite elements* and the power of this numerical method is that they are easy to implement, and all computations are done in logically rectangular coordinates. (Received January 25, 2012)

1080-35-181 **Masaharu Taniguchi*** (masaharu.taniguchi@is.titech.ac.jp), Dept of Mathematical and Computing Sciences, Tokyo Institute of Technology, O-okayama 2-12-1-W8-38, Tokyo 152-8552, Tokyo, 152-8552, Japan. *Traveling fronts of pyramidal shapes in competition-diffusion equations.*

A competition-diffusion system has a one-dimensional traveling front. This paper studies traveling front solutions of pyramidal shapes in competition-diffusion systems in \mathbb{R}^N with $N \geq 2$. By using a multi-scale method, we construct a supersolution and a subsolution, and find a pyramidal traveling front solution between them. This work is a joint work with Professor Wei-Ming Ni of East China Normal University and University of Minnesota. (Received January 26, 2012)

1080-35-196 **yuanwei Qi*** (warrenqi@hotmail.com), 4000 Central Florida BLVD, Orlando, FL 32828. *Global Dynamics of Reaction-diffusion System Arising from Auto-Catalysis.*

In this paper, we study the Cauchy problem of a cubic auto-catalytic chemical reaction system

$$u_{1,t} = u_{1,xx} - u_1 u_2^2, \quad u_{2,t} = d u_{2,xx} + u_1 u_2^2$$

with non-negative initial data, where the constant $d > 0$ is the Lewis number. Our purpose is to study the global dynamics of solutions under mild decay of initial data as $|x| \rightarrow \infty$. In particular, we show that for a substantial class of L^1 initial data, the exact large time behaviour of solutions is characterized by a universal, non-Gaussian spatio-temporal profile, subject to the apparent conservation of total mass. (Received January 26, 2012)

1080-35-198 **Quanhai Lin*** (qhlin@math.brown.edu), 151 Thayer St., Providence, RI 02912. *Soliton dynamics for a non-Hamiltonian perturbation of mKdV.*

We study the dynamics of soliton solutions to the perturbed mKdV equation $\partial_t u = \partial_x(-\partial_x^2 u - 2u^3) + \epsilon V u$, where $V \in C_b^1(\mathbb{R})$, $0 < \epsilon \ll 1$. This type of perturbation is non-Hamiltonian. Nevertheless, via symplectic considerations, we show that solutions remain $O(\epsilon \langle t \rangle^{1/2})$ close to a soliton on an $O(\epsilon^{-1})$ time scale. Furthermore, we show that the soliton parameters can be chosen to evolve according to specific exact ODEs on the shorter, but still dynamically relevant, time scale $O(\epsilon^{-1/2})$. Over this time scale, the perturbation can impart an $O(1)$ influence on the soliton position. (Received January 26, 2012)

1080-35-200 **Marius Beceanu and Michael Goldberg*** (goldbem1@ucmail.uc.edu), Department of Mathematical Sciences, University of Cincinnati, Cincinnati, OH 45221-0025. *Estimates for the Wave Equation with a Rough Potential.*

We prove several families of bounds for the linear wave equation in \mathbf{R}^3 driven by $H = -\Delta + V(x)$, where the class of admissible potentials includes the Lorentz space $L^{3/2,1}(\mathbf{R}^3)$. The estimates include a full range of dispersive and Strichartz inequalities, as well as an additional collection of Strichartz-type bounds in the mixed spaces $L_x^p L_t^q$.

As a corollary we discover that solutions in the energy space are almost-everywhere continuous with respect to time. (Received January 27, 2012)

1080-35-204 **Timur Akhunov*** (takhunov@ucalgary.ca), Department of Mathematics, University of Calgary, 2500 University Dr NW, Calgary, AB T2N 1N4, Canada. *Local wellposedness of quasilinear systems of PDE generalizing KdV.*

In this talk I will discuss local well-posedness of an Initial Value problem associated to a system of PDE's generalizing the Korteweg-de Vries Equation (KdV). These results, inspired by the approach of Kenig-Ponce-Vega from the Quasi-Linear Schrödinger equation, apply to a large class of systems of KdV type. I will give an outline of the proof emphasizing the local smoothing estimates that allow the argument to proceed via the artificial viscosity energy method. (Received January 27, 2012)

1080-35-206 **J. Douglas Wright*** (jdoug@math.drexel.edu). *Well-posedness Issues in Degenerate Dispersive Equations.*

Linear dispersion plays a fundamental role in the study of a large number of physical scenarios and has been the subject of intense theoretical development in recent years. Consequently there has been an explosion of results concerning nonlinear dispersive equations. Nevertheless there are situations in which the mechanism which creates dispersion is itself nonlinear and degenerate. Examples can be found in the study of sedimentation, magma dynamics, granular media, numerical analysis and elasticity. Little is understood about general well-posedness issues for such equations. In this talk we will discuss some recent results which show that degenerate dispersive effects can result in catastrophic instability akin to a backwards heat equation. (Received January 27, 2012)

1080-35-213 **Antoine Mellet*** (mellet@math.umd.edu). *Fronts propagation for some non-local reaction diffusion equations.*

We will present various results concerning the existence and asymptotic behavior of fronts for some non-local reaction diffusion equations arising in combustion theory. (Received January 27, 2012)

1080-35-217 **David Iron*** (iron@mathstat.dal.ca), Chase Building, Department of Mathematics and Statistics, Halifax, NS, Canada, and **Chris Levy**. *Model of Intracellular Signaling Pathways.*

Intracellular signaling molecules form pathways inside the cell. These pathways carry a signal from the cell membrane to target proteins which results in cellular responses. We consider a spherical cell with compartments containing localized activating enzymes. Diffusible signaling molecules are activated at the compartments and later deactivated in the cytosol due to deactivating enzymes. The signaling molecules act as molecular switches to form a self regulated system involving positive and negative feedback. We use matched asymptotic expansions to construct solutions and analyze the dynamic behaviour of the system. We show that much of the complex behaviour of the full 3 dimensional partial differential equation can be approximated by a suitable system of ordinary differential equations. (Received January 27, 2012)

1080-35-227 **Xiaoyi Zhang*** (xiaozhang@math.uiowa.edu), 14 Maclean Hall, Iowa city, IA 52242. *Energy critical NLS on the exterior domain of a ball in \mathbb{R}^3 .*

We will discuss recent work on the energy critical NLS on the exterior domain of a unit ball. (Received January 27, 2012)

1080-35-231 **Erwin Suazo***, erwin.suazo@upr.edu, and **Sergei K. Suslov**. *Soliton-like Solutions for Nonlinear Schroedinger Equation with Variable Quadratic Hamiltonians.*

For nonlinear Schroedinger equation with variable coefficients we construct soliton-like solutions for certain choices of the coefficients, including important examples such as bright and dark solitons and Jacobi elliptic and second Painlevé transcendental solutions, which are important for current research in nonlinear optics and Bose–Einstein condensation. Also we show an example of existence of L^∞ finite time blowup for subcritical NLS. In the linear case we are able to construct the fundamental solution explicitly. We will give several examples inspired from solvable cases of the Riccati equation and emphasize an example involving Airy functions. A large part of the results presented have been done in joint work with Sergei K. Suslov. (Received January 28, 2012)

1080-35-237 **Nicholas D Alikakos*** (nalikako@math.uoa.gr), Agiou Iwannoy theologou 42-44, Xolargos, 15561 Athens, Greece. *PDE connections for systems with variational structure.* Preliminary report.

Abstract: We consider the elliptic system

$L(u) - \text{grad } W(u) = 0$, where L stands for the Laplacian, and where W is a double well potential defined over \mathbb{R}^m . The system is considered on a class of n -dimensional spatial domains which are unbounded in one direction and possess a non-flat boundary, together with Neumann boundary conditions for u . We are interested in solutions (maps of the n -dimensional domain into \mathbb{R}^m) connecting at plus-minus infinity the minima of the potential. (Received January 28, 2012)

1080-35-242 **Geordie Richards*** (griehard@math.toronto.edu), BA 6135, 40 St. George Street, Toronto, Ontario M5S 2E4, Canada. *Invariance of the Gibbs measure for the periodic quartic KdV.*

The periodic generalized Korteweg-de Vries equation (gKdV) can be interpreted as an infinite-dimensional Hamiltonian system. Some properties of finite-dimensional Hamiltonian dynamics can be extended to infinite dimensions; for example, the invariance of the Gibbs measure under the flow. While interesting in its own right, an invariant Gibbs measure also provides a mathematical tool for extending local solutions at low regularities (in the support of the Gibbs measure) to global solutions. We present the invariance of the Gibbs measure for the gauge-transformed quartic KdV. As a corollary, we obtain global well-posedness almost surely for the (un-gauged) quartic KdV at regularities where this PDE is analytically ill-posed. (Received January 28, 2012)

1080-35-245 **Sergey A Dyachenko** and **Pavel M Lushnikov***, Department of Mathematics and Statistics, MSC01 1115, 1 University of New Mexico, Albuquerque, NM 87131, and **Natalia Vladimirova**. *Logarithmic-type scaling of the collapse of Keller-Segel equation.*

Keller-Segel equation (KS) is a parabolic-elliptic system of partial differential equations with applications to bacterial aggregation and collapse of self-gravitating gas of brownian particles. KS has striking qualitative similarities with nonlinear Schrodinger equation (NLS) including critical collapse (finite time point-wise singularity)

in two dimensions. The self-similar solutions near blow up point are studied for KS in two dimensions together with time dependence of these solutions. We found logarithmic-type modifications to $(t_0 - t)^{1/2}$ scaling law of self-similar solution in qualitative analogy with log-log modification for NLS. We found very good agreement between the direct numerical simulations of KS and the analytical results obtained by developing a perturbation theory for logarithmic-type modifications. It suggests that log-log modification in NLS also could be verified in a similar way. (Received January 28, 2012)

1080-35-246 **J. Marzuola, S. Raynor*** (raynorsg@wfu.edu) and **G. Simpson**. *The Dynamics of Perturbations of Minimal Mass Solitons*. Preliminary report.

We study soliton solutions to several nonlinear dispersive equations with saturated nonlinearities. We consider a small perturbation of a minimal mass soliton and identify a system of ODEs which models the behavior of such perturbations for short times. This extends the work of Comech and Pelinovsky and of Comech, Cuccagna, and Pelinovsky, for the Nonlinear Schrödinger (NLS) and Korteweg-deVries (KdV) equations, respectively. For NLS, we provide numerical evidence that under this system of ODEs there are two possible dynamical outcomes, in accord with the conclusions of Pelinovsky, Afanasjev and Kivshar. Generically, initial data which supports a soliton structure appears to oscillate, with oscillations centered on a stable soliton. For initial data which is expected to disperse, the finite dimensional dynamics initially follow the unstable portion of the soliton curve. For the generalized KdV equation with saturated nonlinearity, we provide initial evidence that the dynamics of a small perturbation of the minimal mass soliton are governed by a simple two-dimensional system of ODEs. Analysis of the phase plane indicates that the solution either disperses or eventually approaches a nearby stable soliton, without oscillation. (Received January 29, 2012)

1080-35-252 **Magdalena Czubak*** (czubak@math.binghamton.edu). *Virial identity and blowup for the nonabelian Chern-Simons-Schrödinger system*. Preliminary report.

Chern-Simons-Schrödinger system arises as a model for anyons, particles with statistics in between Fermions and Bosons. Mathematically, we can view it as a focusing cubic NLS in 2D, where we replace the standard derivatives by covariant ones with the corresponding gauge fields governed by the Chern-Simons dynamics. The system can be considered both in the abelian and nonabelian setting. The virial identity leading to blow up in the abelian case has been known. We will describe a computation resulting in the virial identity in the nonabelian case. Then using the pseudoconformal invariance of the equations and the self-dual Chern-Simons solitons we construct explicit blowup solutions for the nonabelian system. (Received January 29, 2012)

1080-35-271 **Nikolaos Tzirakis*** (tzirakis@math.uiuc.edu), University of Illinois at Urbana-Champaign, 1409 W Green Street, Urbana, IL 61801, and **Burak Erdogan**. *Smoothing effect for dispersive equations and systems with periodic boundary conditions*.

We consider the periodic KdV and the periodic Zakharov system in one dimension. We prove that the difference of the nonlinear and the linear evolution is in a smoother space than the initial data. The method is based on normal form calculations and it is quite general. In our talk we also discuss some applications of this smoothing effect to the corresponding nonlinear evolutions. This is joint work with B. Erdogan. (Received January 30, 2012)

1080-35-276 **rana parshad*** (rana.parshad@kaust.edu.sa), applied mathematics and scientificcomputation, thuwal, western 23955, Saudi Arabia, and **folashade agusto**, clarksville, TN 37044. *Mosquito management in the face of natural selection*.

In this paper we study the long time dynamics of a reaction diffusion system, describing the spread of *Aedes aegypti* mosquitoes, which are the primary cause of dengue infection. The system incorporates a control attempt via the sterile insect technique. The model incorporates female mosquitoes sexual preference for wild males over sterile males. We show the existence of a global attractor for the system in L^2 . The attractor is shown to possess state of extinction, if the injection of sterile males is large enough. We then apply optimal control theory to our model and show how natural selection for female choosiness, fundamentally alters management strategies. (Received January 30, 2012)

1080-35-283 **naveen k vaidya** (nvaidya2@uwo.ca), Department of Applied Mathematics, University of Western Ontario, London, Ontario N6A 5B7, Canada, **feng-Bin wang** (wfengbin@uwo.ca), Department of Applied Mathematics, University of Ontario, London, Ontario N6A 5B7, Canada, and **xingfu zou*** (xzou@uwo.ca), Department of Applied Mathematics, University of Western Ontario, London, Ontario N6A 5B7, Canada. *On a PDE system modeling avian Influenza dynamics in wild birds with spatial heterogeneous environment.*

In this talk, I will report some results on a mathematical model that describes the avian influenza dynamics in wild birds with bird mobility and heterogeneous environment incorporated. In addition to basic properties of solutions to the model, we also prove the threshold dynamics which can be expressed either by the basic reproductive number or by the principal eigenvalue of the linearization at the disease free equilibrium. When the environment factor in the model becomes a constant (homogeneous environment), we are able to find explicit formulas for the basic reproductive number and the principal eigenvalue. I will also present some numerical simulation results to show the impact of the heterogeneous environment on the disease dynamics. Our analytical and numerical results reveal that the avian influenza dynamics in wild birds is highly affected by both bird mobility and environmental heterogeneity. (Received January 30, 2012)

1080-35-298 **Fang Li** and **Nugn Kwan Yip*** (yip@math.purdue.edu), Dept. of Math., Purdue Univ., 150 N. University Street, West Lafayette, IN 47907. *Blow up phenomena for a shadow system of the Gierer-Meinhardt model.*

We will present some results of blow-up phenomena for a shadow system (SS) obtained from the Gierer-Meinhardt model (GM). SS is formally derived by letting the diffusion coefficient of one of the components tend to infinity, leading to a coupled system of a diffusion and an ordinary differential equations. There is a huge discrepancy in terms of the long time behaviors between the SS and GM systems. We will demonstrate this using integral estimates and a fixed point theorem. (Received January 30, 2012)

1080-35-348 **John Andersson**, **Henok Mawi*** (henok.mawi@howard.edu) and **Henrik Shahgholian**. *Regularity of Solutions of a Biharmonic Free Boundary Problem.* Preliminary report.

Let Ω be a domain in \mathbb{R}^n with $0 \in \partial\Omega$. Suppose in B , the unit ball in \mathbb{R}^n , u and Ω satisfy the following equation in the sense of distributions:

$$\begin{aligned} \Delta^2 u &= \chi_\Omega \text{ in } B \\ D^\alpha u &= 0 \text{ for } |\alpha| \leq 3 \text{ in } B \setminus \Omega. \end{aligned}$$

Here Δ^2 is the Biharmonic operator and χ_Ω denotes the characteristic function.

We analyze the regularity properties of the function u . (Received January 31, 2012)

1080-35-349 **Shigui Ruan*** (ruan@math.miami.edu), Department of Mathematics, University of Miami, Coral Gables, FL 33124-4250. *Hopf Bifurcation for Non-densely Defined Cauchy Problems and Applications to a Size-structured Population Dynamic Model with Random Growth.*

We establish a Hopf bifurcation theorem for abstract Cauchy problems in which the linear operator is not densely defined and is not a Hille-Yosida operator. The theorem is proved by using the center manifold theory for non-densely defined Cauchy problems associated with the integrated semigroup theory. As an application, the existence of Hopf bifurcation in a size-structured model with Ricker type birth function as well as random fluctuation in the growth process is studied. The model takes the form of a reaction-diffusion equation with a nonlinear and nonlocal boundary condition. (Received January 31, 2012)

1080-35-368 **Yoshihito Oshita*** (oshita@math.okayama-u.ac.jp), Okayama, Japan. *Dynamics for an evolution equation describing micro phase separation.*

We study the mean-field models describing the evolution of distributions of particle radii obtained by taking the small volume fraction limit of the free boundary problem describing the micro phase separation of diblock copolymer melts, where micro phase separation consists of an ensemble of small balls of one component. In the dilute case, we identify all the steady states and show the convergence of solutions.

Next we study the dynamics for a free boundary problem in two dimension, obtained as a gradient flow of Ohta-Kawasaki free energy, in the case that one component is a distorted disk with a small volume fraction. We show the existence of solutions that a small, almost circular interface moves along a curve determined via a Green's function of the domain. This talk is partly based on a joint work with Xiaofeng Ren. (Received January 31, 2012)

1080-35-385 **Yoshihito Oshita*** (oshita@math.okayama-u.ac.jp), Okayama, Japan. *Dynamics for an evolution equation describing micro phase separation.*

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37 ► *Dynamical systems and ergodic theory*

1080-37-2 **Boris Solomyak***, solomyak@uw.edu. *Some recent advances in tiling dynamical systems.*

This talk will focus on self-similar and self-affine tilings of the Euclidean space. Such tilings arise in many different contexts, notably in logic (aperiodic tilings), physics (quasicrystals), dynamics (Markov partitions for hyperbolic maps, tiling dynamics), and number theory (radix representations). The first part of the talk will be a survey of some of these connections. We will then describe some recent advances and open problems in the study of tiling dynamical systems; in particular, on the characterization of expansion maps for self-affine tilings (joint work with R. Kenyon), on discrete spectrum (joint work with J.-Y. Lee), and on the deviation of ergodic averages (joint work with A. Bufetov). (Received January 19, 2012)

1080-37-64 **David Damanik***, Department of Mathematics, MS-136, Rice University, Houston, TX 77251. *The Spectrum of the Weakly Coupled Fibonacci Hamiltonian.* Preliminary report.

We report on recent joint work with Anton Gorodetski (UC Irvine) on the spectrum of the weakly coupled Fibonacci Hamiltonian and present results on the fractal properties of this set as well as the equilibrium measure associated with it. (Received January 02, 2012)

1080-37-80 **Yunjiao Wang*** (yw19@rice.edu), 6100 Main Street, CAAM, Rice University, Houston, TX 77005, and **Marty Golubitsky** and **David Romano**. *Rigid phase-shifts in periodic solutions of network systems.*

This work is motivated by animal gaits, which are time periodic and in which the movements of legs are robustly phase-related. A natural question arises: what kind of network systems may support periodic solutions with such robust phase-relations? In this talk, I will show that only those networks with 'certain symmetries' can admit this kind of solutions. The result may be not very surprising. The proof, however, took researchers in the field of coupled cell systems more than a decade. (Received January 10, 2012)

1080-37-83 **Lora Billings*** (billingsl@mail.montclair.edu), Department of Mathematical Sciences, Montclair, NJ 07043, and **Jackson Burton**, **Derek Cummings** and **Ira Schwartz**. *Disease Persistence in Epidemiological Models: The Interplay between Vaccination and Migration.* Preliminary report.

We consider the interplay of vaccination and migration rates on disease persistence in epidemiological systems. We show that short-term and long-term migration can inhibit disease persistence. This, in turn, changes how vaccination rates should be chosen to maintain herd immunity. In a system of coupled SIR models, we predict how the vaccination rates depend explicitly on short- and long-term migration rates to keep the disease free equilibrium stable. The analysis suggests novel vaccination policies that underscore the importance of optimal placement of finite resources. (Received January 11, 2012)

1080-37-85 **Karl Petersen*** (petersen@math.unc.edu), Department of Mathematics, CB 3250 Phillips Hall, UNC, Chapel Hill, NC 27599. *Isotropic adic systems.* Preliminary report.

We study a class of adic (Bratteli-Vershik) systems that, though not simple, stationary, or minimal, still are highly regular in that the pattern of edges leaving each vertex is the same. Examples are the Pascal and Delannoy systems, as well as the generalized Pascal systems studied by Xavier Mela and the polynomial systems of Sarah Bailey Frick. We show that Xavier Mela's argument extends to this class to identify all the ergodic invariant measures and that in some cases coding by the first edge produces a faithful representation as a subshift. This is joint work underway with Sarah Bailey Frick. (Received January 11, 2012)

1080-37-130 **M Barge**, Mathematical sciences Department, Bozeman, MT 59715, and **Robert F Williams*** (bob@math.utexas.edu), c1200, 1 University Station, Austin, TX. *Asymptotic structures for Penrose, Tübingen and octagon tilings*. Preliminary report.

The *asymptotic structure* of one dimensional tiling spaces was introduced and used extensively, by Barge and others. It is in effect, a topological invariant. Recently, Barge-Olimb extended this concept to higher dimensional substitution tiling spaces and computed it for several cases: for the “half hexagon”, this is just 3 tilings, fixed under inflation, which differ only near the origin; for the Penrose tiling it has the Fibonacci substitution system as a factor. Here we compute this invariant for the three substitution tiling spaces indicated. In the process we carry out the ‘balanced pair’ algorithm, (also recently extended) verifying that the \mathbb{R}^2 action has pure discrete spectrum in these cases. Of course this last is well known as these tilings can also be presented as cut and project tilings. (Received January 20, 2012)

1080-37-163 **Ethan M. Coven*** (ecoven@wesleyan.edu), **Andrew Dykstra** (adykstra@hamilton.edu), **Michael Keane** (mkeane@wesleyan.edu) and **Michelle LeMasurier** (mlemasur@hamilton.edu). *Necessary and sufficient conditions for a minimal symbolic dynamical system to be topologically conjugate to a given constant length substitution minimal system*. Preliminary report.

Extending results of three of the authors on the famous Morse Minimal Set (ETDS 2008), we show that a symbolic minimal system (Y, σ) is topologically conjugate to (X_θ, σ) , an infinite substitution minimal system generated by a primitive, one-to-one substitution θ of constant length L if and only if there exists an integer $N \geq 1$ and a collection $\{C_i\}$ of L^N -blocks appearing in Y such that every point in Y can be written uniquely as a concatenation of blocks C_i and every such concatenation “mirrors” a point in X_θ in the following sense. The blocks C_i appearing in $\cdots C_{i-1} C_{i_0} C_{i_1} \cdots$ can be labelled with symbols of X_θ , where (1) the sets of labels that can be on C_i and C_j are disjoint if $i \neq j$, (2) the label on a block appearing in $\cdots C_{i-1} C_{i_0} C_{i_1} \cdots$ depends only on its nearest neighbor blocks and not on their labels. (3) the doubly infinite sequence of labels on the blocks appearing in $\cdots C_{i-1} C_{i_0} C_{i_1} \cdots$ is a point in X_θ . (Received January 24, 2012)

1080-37-176 **Scott Schmieding*** (scott@math.umd.edu), **Johannes Kellendonk** and **Marcy Barge**. *Maximal equicontinuous factors and cohomology for tiling spaces*. Preliminary report.

We discuss some results concerning the map induced on cohomology by the factor map onto the maximal equicontinuous factor for a substitution tiling space. In particular, we show that it is injective in degree 1, with torsion free cokernel, and mention a certain splitting problem that arises. (Received January 25, 2012)

1080-37-179 **Kelly B Funk*** (funk3@illinois.edu). *Weakly Mixing Homeomorphisms that are Uniformly Rigid*. Preliminary report.

In this talk we explore some properties of weakly mixing homeomorphisms of \mathbb{T}^2 that are uniformly rigid. We will show that there is a large family of weakly mixing, uniformly rigid, strictly ergodic homeomorphisms of \mathbb{T}^2 . Also, we will show that if a sequence of natural numbers satisfies a certain growth rate, then we can construct a weakly mixing homeomorphism of \mathbb{T}^2 that is uniformly rigid with respect to that sequence. (Received January 25, 2012)

1080-37-209 **Lorenzo Sadun*** (sadun@math.utexas.edu) and **Natalie Frank**. *Complexity of tilings with infinite local complexity*.

Tiling spaces with infinite local complexity (ILC) come in many flavors, from spaces that are topologically conjugate to finite local complexity (FLC) tiling spaces to spaces with multi-dimensional structures in their transversals. A key tool for distinguishing the large-scale structure of these spaces is the tiling complexity function $C(\epsilon, L)$ at precision ϵ and length scale L , and particularly the behavior as $L \rightarrow \infty$. We illustrate this function by examining the tiling complexity of a number of different examples. (Received January 27, 2012)

1080-37-210 **Eugen Andrei Ghenciu*** (eghenciu@ecok.edu) and **Mario Roy**. *Fractals Generated by Non Sofic Subshifts*. Preliminary report.

We look at fractals generated by non sofic subshifts over a finite alphabet and we investigate whether the Bowen formula holds. We look at two examples, the context free shift and the even sofic shift. (Received January 27, 2012)

1080-37-211 **Konstantin Medynets*** (medynets@math.ohio-state.edu) and **Boris Solomyak** (solomyak@math.washington.edu). *Second order ergodic theorem for substitution tiling systems*. Preliminary report.

We establish the second order ergodic theorem for the class of *non-minimal* substitution tiling systems. Namely, let $(\Omega, \mu, \{T^u\}_{u \in \mathbb{R}^t})$ be a substitution tiling system preserving an infinite ergodic measure μ . Assume that the measure μ is non-zero and finite on some open subset of Ω . Then there exist positive parameters d and c such that for μ -almost every point $x \in \Omega$ and for every function $f \in L^1(\Omega, \mu)$, we have

$$\lim_{t \rightarrow \infty} \frac{1}{\log(t)} \int_0^t \frac{\int_{B_R} f(T^u(x)) du}{cR^d} \frac{dR}{R} = \int_{\Omega} f d\mu,$$

where B_R is the ball of radius R . The parameters d and c arise as the Hausdorff dimension and logarithmic density of a certain graph-directed set associated to the substitution rule. Our result is also applicable to one-dimensional symbolic substitution systems. (Received January 27, 2012)

1080-37-222 **Samuel Lightwood, Ayşe Şahin*** (asahin@depaul.edu) and **Ilie Ugarcovici**. *The structure and spectrum of Heisenberg odometers*. Preliminary report.

Odometers, aka adding machines, are classical and ubiquitous examples of discrete dynamical systems. In this talk we study odometer actions of the Heisenberg group. We provide a complete classification of Heisenberg odometers based on the structure of their defining subgroups. We also describe how this structure determines the representations of the Heisenberg group which can arise in the spectrum of an odometer action. (Received January 27, 2012)

1080-37-225 **Niketa Salvi*** (salvi@math.colostate.edu). *Proving Rudolph's two-step coding theorem in the nearly continuous category*.

In measurable dynamics, one studies the measurable properties of dynamical systems. A recent surge of interest has been to study dynamical systems which have both measurable and topological structures. A nearly continuous dynamical system (NCDS) consists of a Polish space X with a non-atomic Borel probability measure μ and an ergodic measure-preserving homeomorphism T on X . Let $f : X \rightarrow \mathbb{R}$ be a positive, nearly continuous measure-preserving function bounded away from 0 and ∞ . This gives rise to a flow built under the ceiling function f in the nearly continuous category. Rudolph proved a representation theorem in the 1970's, showing that any measurable flow (where the function f above is only assumed to be measure-preserving on a measurable dynamical system) can be represented as a flow built under a function where the ceiling function takes only two values. We show that Rudolph's theorem holds in the nearly continuous category. (Received January 27, 2012)

1080-37-236 **Mike Boyle*** (mmb@math.umd.edu). *Ordered cohomology of Bratteli-Vershik transformations, beyond dimension groups*. Preliminary report.

The Bratteli-Vershik scheme for modeling transformations led to the dramatic Giordano-Putnam-Skau classification of minimal transformations of the Cantor set up to topological orbit equivalence by ordered cohomology invariants. I'll discuss the ordered cohomology of more general homeomorphisms of the Cantor set. This is primarily from joint work with David Handelman. (Received January 28, 2012)

1080-37-255 **Tyler M White*** (twhite5@gwu.edu), The George Washington University, 2115 G St. NW, Washington, DC 20052. *Topological Mixing Tilings of \mathbb{R}^2 Generated by a Generalized Substitution*.

Kenyon, in his 1996 paper, gave a class of examples of tilings of \mathbb{R}^2 constructed from generalized substitutions. These examples are topologically conjugate to self-similar tilings of the plane (with fractal boundaries). I have proven that an infinite sub-family of Kenyon's examples are topologically mixing, and as a result, provides the first known examples of self-similar topologically mixing tiling dynamical systems of \mathbb{R}^2 . (Received January 29, 2012)

1080-37-256 **Michael H. Schraudner*** (mschraudner@dim.uchile.cl), Centro de Modelamiento Matemático, Universidad de Chile, Av. Blanco Encalada 2120, Of. 704, Santiago, Chile. *Entropies realizable in block gluing \mathbb{Z}^d shifts of finite type*.

We report on recent joint work with Ronnie Pavlov.

Hochman and Meyerovitch gave a complete characterization of the topological entropies appearing in \mathbb{Z}^d shifts of finite type (SFTs). Nevertheless their method of construction is quiet rigid and yields only relatively degenerate \mathbb{Z}^d SFTs being a specific extension of a non-trivial zero-entropy factor and lacking any strong mixing property.

In this short presentation we will give a necessary condition for a real number to be realizable as the topological entropy of a block gluing \mathbb{Z}^d SFT. Subsequently we will present a technique to realize a large class of well-behaved

real numbers as entropies of block gluing \mathbb{Z}^d SFTs for any $d > 2$. As a final corollary we get a result about the non-existence of equal-entropy \mathbb{Z}^d full-shift factors. (Received January 29, 2012)

1080-37-275 **Maki Furukado*** (furukado@ynu.ac.jp), Tokiwadai 79-4, Hodogaya-ku, Yokohama, 240-8501, and **Shunji Ito** (shunjiito@gmail.com), Kakuma-machi, Kanazawa, 920-1192. *Non-Pisot substitutions from RID and quasi-periodic tilings.* Preliminary report.

Starting from the unimodular Pisot substitution σ of the free monoid on the alphabet $\{1, 2, \dots, d\}$, we are able to obtain the family of the sets $\{X_i\}_{i=1,2,\dots,d}$ satisfying following properties: (1) X_i is the set of A^{-1} -invariant plane and the closure of the interior of X_i is equal to X_i ; (2) $A^{-1}X_i = \bigcup_{j=1}^{l_i} (v_j^{(i)} + X_j)$ (non-overlapping) where A is the matrix of σ and the vectors $v_j^{(i)} \in \mathcal{P}$ are some translations; (3) $\{X_i\}_{i=1,2,\dots,d}$ is the set of prototiles of a certain quasi-periodic tiling of the plane \mathcal{P} .

In this talk, we would like to extend the above to the case of the unimodular non-Pisot substitution on the alphabet $\{1, 2, 3, 4\}$. In particular, we focus on generating the 2-dimensional quasi-periodic tiling by using the unimodular, non-Pisot substitution given by the Rauzy induction diagram (RID). (Received January 30, 2012)

1080-37-287 **David Koslicki** and **Daniel J Thompson*** (thompson@math.psu.edu). *Topological pressure and a priori coding sequence density estimation in the human genome.*

Inspired by concepts from ergodic theory, we introduce a new approach to coding sequence (CDS) density estimation for the human genome. Our approach is based on the introduction and study of topological pressure: a quantity assigned to any finite sequence based on an appropriate notion of ‘weighted information content’. For human DNA sequences, each codon is assigned a suitable weight, and using a window size of approximately 60,000bp, we obtain a very strong positive correlation between CDS density and topological pressure. The weights are selected by an optimization procedure, and can be interpreted as quantitative data on the relative importance of different codons for the density estimation of coding sequences. We emphasize that topological pressure is a flexible tool and we expect it to be useful for the investigation of many other features of DNA sequences such as interspecies comparison of codon usage bias. We give a first result in this direction, investigating CDS density in the mouse genome and comparing our results with those for the human genome. (Received January 30, 2012)

1080-37-288 **Elena S Dimitrova*** (edimit@clmson.edu), O-303 Martin Hall, Department of Mathematical Sciences, Clemson University, Clemson, SC 29634-0975. *Modeling biological networks with functions with canalizing properties.*

Finite dynamical systems have emerged as a prominent tool for modeling biological systems. Nested canalizing functions, a particular class of Boolean functions, possess properties that make them especially suitable for modeling of biological networks. However, for the purpose of reverse engineering, relaxing the canalizing requirement on some variables is necessary. In this talk, I will introduce the class of partially nested canalizing functions and their application to studying gene regulatory networks. (Received January 30, 2012)

1080-37-289 **Reem Yassawi*** (ryassawi@trentu.ca), Dept. of Mathematics, Trent University, 1600 West Bank Drive, Peterborough, Ontario K9J7B8, Canada, and **Sergey Bezuglyi** and **Jan Kwiatkowski**. *Orders whose Vershik maps are odometers.*

We give explicit conditions for a Bratteli diagram B to support an order ω such that the corresponding adic map $\phi_\omega : X_B \rightarrow X_B$ is conjugate to an odometer. This is joint work with S. Bezuglyi and J. Kwiatkowski. (Received January 30, 2012)

1080-37-327 **Natalie Priebe Frank*** (nafrank@vassar.edu), Box 248, Vassar College, Poughkeepsie, NY 12604, and **Lorenzo Sadun** (sadun@math.utexas.edu), Department of Mathematics, The University of Texas at Austin, Austin, TX 78712. *Fusion rules for tilings with finite or infinite local complexity.* Preliminary report.

Fusion rules produce hierarchical structure in tilings like that in substitution sequences and self-similar tilings. We will present a definition of fusion for tilings that applies not only to tilings with finite prototile sets, but also tilings with compact prototile sets. This gives us a way to think about hierarchical structure for tilings with infinite local complexity. We will now show several examples, some known and some new, fit into the fusion framework. (Received January 31, 2012)

1080-37-343 **Sarah Bailey Frick*** (sarah.frick@furman.edu), Mathematics Department, 3300 Poinsett Hwy, Greenville, SC 29613, and **Karl Petersen**. *Complexity and dimension groups of isotropic adic systems.* Preliminary report.

Isotropic adic systems are systems where the pattern of edges leaving each vertex are the same. We allow for special edges that connect nonconsecutive levels. Some examples include the well known Pascal adic as well as

the Delonnoy adic. In this talk we discuss the complexity and dimension groups of such adic systems. This is joint work underway with Karl Petersen. (Received January 31, 2012)

1080-37-353 **Frederic Latremoliere** (Frederic.Latremoliere@du.edu), 2360 S. Gaylord St, Denver, CO 80208, and **Nic Ormes*** (normes@du.edu), 2360 S. Gaylord St, Denver, CO 80208. *C*-Algebraic Characterization of Bounded Orbit Injection Equivalence for Minimal Cantor Systems.*

We will consider minimal \mathbf{Z}^d Cantor systems and discuss bounded orbit injection equivalence, an extension of the notion of Kakutani equivalence for \mathbf{Z} actions. The second author, in a joint paper with Lightwood, showed that for $d = 2$ this relation is equivalent to the existence of a homeomorphism between suspension spaces. In this talk we will discuss the interplay between this relation on \mathbf{Z}^d Cantor systems, ordered group invariants and C^* -algebraic invariants. (Received January 31, 2012)

1080-37-359 **Bernd Sing*** (bernd.sing@cavehill.uwi.edu), Department of CS, Mathematics & Physics, University of the West Indies, Cave Hill, P.O. Box 64, Bridgetown, St Michael BB11000, Barbados. *Markov partitions in the non-unimodular case.* Preliminary report.

We consider hyperbolic toral automorphisms that arise in the study of substitution tilings. It is known (Anderson and Putnam, *Ergod. Th. & Dynam. Sys.* **18**) that the action of a tiling substitution on its associated tiling space is always a Smale space. In fact, often we get a hyperbolic toral automorphism, and the tile substitution induces a Markov partition on the tiling space. However, examples of explicit constructions of such Markov partitions seem to be restricted to unimodular Pisot-type substitutions (e.g., Praggastis, *Trans. AMS* **351**).

In this talk we consider the non-unimodular case: Are there non-unimodular hyperbolic toral automorphisms? Can we calculate their entropy? How do the induced Markov partitions look like? (Received January 31, 2012)

39 ► Difference and functional equations

1080-39-31 **M Cristina Caputo*** (caputo@math.utexas.edu), Austin, TX 78701, and **Delfim Torres**, Aveiro, Porto, Portugal. *Duality for the left and right fractional derivatives.*

We prove a duality result between the left and right fractional derivatives. These results apply to the Riemann-Liouville, and Caputo derivatives. Applications in optimal control theory problems in the context of time scales are provided. (Received December 05, 2011)

1080-39-73 **Youssef Naim Raffoul*** (yraffoul1@notes.udayton.edu), Dayton, OH 45469-2316, **Xinyuan Liao**, Peoples Rep of China, and **Shengfan Zhou**, Peoples Rep of China. *On the Permanence of discrete-time multi-species competition predation system with several delays.*

By new method of difference inequality, it is shown that the system

$$\begin{aligned} x_i(n+1) &= x_i(n) \exp\{r_i(n) - a_i(n)x_i(n) - \sum_{k=1}^l a_{ik}(n)x_k(n - \tau_{ik}) \\ &\quad - \sum_{k=1}^m e_{ik}(n)y_k(n - \eta_{ik})\}, \\ y_j(n+1) &= y_j(n) \exp\{-b_j(n) - c_j(n)y_j(n) + \sum_{k=1}^l d_{jk}(n)x_k(n - \delta_{jk}) \\ &\quad - \sum_{k=1}^m c_{jk}(n)y_k(n - \xi_{jk})\}, \end{aligned} \quad (1.1)$$

$$x_i(\theta) = \phi_i(\theta) \geq 0, \quad y_j(\theta) = \psi_j(\theta) \geq 0, \quad \theta \in \mathbb{N}[-\tau, 0] := \{-\tau, -\tau + 1, \dots, -1, 0\},$$

where $i = 1, 2, \dots, l$; $j = 1, 2, \dots, m$; τ_{ik} , η_{ik} , δ_{jk} and ξ_{jk} are nonnegative integers; $\phi_i(0) > 0$, $\psi_j(0) > 0$;

$$\tau = \max\left\{\max_{1 \leq i, k \leq l} \tau_{ik}, \max_{1 \leq i \leq l; 1 \leq k \leq m} \eta_{ik}, \max_{1 \leq k \leq l; 1 \leq j \leq m} \delta_{jk}, \max_{1 \leq j, k \leq m} \xi_{jk}\right\} > 0;$$

is permanent under some appropriate conditions. Moreover, we give an example to illustrate the feasibility of our result.

(Received January 09, 2012)

1080-39-115 **Hassan Sedaghat*** (hshedagha@vcu.edu). *Global attractivity in a general class of nonlinear difference equations.*

Using recent results on reduction of order, we derive new sufficient conditions for the convergence to zero of all solutions of the non-autonomous, higher order difference equation

$$x_{n+1} = \sum_{i=0}^k a_i x_{n-i} + g_n \left(\sum_{i=0}^k b_i x_{n-i} \right)$$

(Received January 18, 2012)

1080-39-142 **Candace Marie Kent*** (cmkent@vcu.edu), Virginia Commonwealth University, Dept. of Math. & Applied Math., 1015 Floyd Avenue, P.O. Box 842014, Richmond, VA 23284-2014, and **Witold Kosmala**. *On the Difference Equation $x_{n+1} = x_{n-\ell}x_{n-k} - 1$* . Preliminary report.

Our ultimate goal is to understand the long-term behavior of solutions of the difference equation

$$x_{n+1} = x_{n-\ell}x_{n-k} - 1, n = 0, 1, \dots,$$

where the initial conditions are real. To this end, we review our results on the boundedness, the monotonicity, the periodicity, the asymptotic periodicity, and the existence of unbounded solutions for the four specific cases

- (i) $\ell = 1, k = 2$,
- (i) $\ell = 0, k = 1$,
- (i) $\ell = 0, k = 2$,
- (i) $\ell = 0, k = 3$.

We also present an unboundedness result for $x_{n+1} = x_{n-\ell}x_{n-k} - 1$ in general. (Received January 22, 2012)

1080-39-146 **M Drymonis, y. Kostrov*** (ykostrov@xula.edu) and **Z Kudlak** (zachary.kudlak@msmc.edu). *On Rational Difference Equations with Periodic Coefficients, Part 1*. Preliminary report.

We investigate the boundedness and convergence of solutions to second-order rational difference equations of the form

$$x_{n+1} = \frac{\alpha_n + \beta_n x_n x_{n-1} + \gamma_n x_{n-1}}{A_n + B_n x_n x_{n-1} + C_n x_{n-1}}$$

where the coefficients $\alpha_n, \beta_n, \gamma_n, A_n, B_n, C_n$ are nonnegative and periodic. This is part one of a two-part talk. (Received January 22, 2012)

1080-39-147 **Emmanouil Drymonis**, Kingston, RI 02881, **Yevgeniy Kostrov**, New Orleans, LA 70125, and **Zachary Kudlak*** (zachary.kudlak@msmc.edu), Newburgh, NY 12550. *On Rational Difference Equations with Periodic Coefficients, Part 2*.

We investigate the boundedness and convergence of solutions to second-order rational difference equations of the form

$$x_{n+1} = \frac{\alpha_n + \beta_n x_n x_{n-1} + \gamma_n x_{n-1}}{A_n + B_n x_n x_{n-1} + C_n x_{n-1}}$$

where the coefficients $\alpha_n, \beta_n, \gamma_n, A_n, B_n, C_n$ are nonnegative and periodic. This is part two of a two-part talk. (Received January 29, 2012)

1080-39-186 **Harold M Hastings*** (harold.hastings@hofstra.edu), Dept of Physics and Astronomy-Berliner 102, 151 Hofstra University, Hempstead, NY 11549-1510. *Fuzzy passage through a Hopf bifurcation*.

Many dynamical systems in nature (biochemical oscillators, the Belousov-Zhabotinsky reaction, networks of neurons, etc.) (a) can be modeled by systems of stochastic difference equations, and (b) exhibit transitions from steady-state to oscillatory behavior through Hopf bifurcations. This talk will discuss the fuzzy nature of slow transitions through a Hopf bifurcation [SM Baer, T Erneux and J Rinzel. The Slow Passage Through a Hopf Bifurcation: Delay, Memory Effects, and Resonance. SIAM J Appl Math, 49, 55-71 (1989). SM Baer and EM Gaekel. Slow acceleration and deceleration through a Hopf bifurcation: Power ramps, target nucleation, and elliptic bursting. Phys Rev E 78, 036205 (2008).] with applications to the fluctuation-driven formation of pacemakers in the Belousov-Zhabotinsky reaction [HM Hastings, SG Sobel, RJ Field et al., Bromide Control, Bifurcation and Activation in the Belousov-Zhabotinsky Reaction. J Phys Chem. A 112 4715-4718 (2008).]. (Received January 26, 2012)

1080-39-304 **Anatoli F Ivanov*** (afi1@psu.edu), Old Rt 115, PO Box PSU, PA 18708, **Musa A Mammadov**, University of Ballarat, Ballarat, Australia, and **Sergei I Trofimchuk**, University of Talca, Talca, Chile. *Asymptotic stabilization in an optimal control problem with time-delay*.

A class of scalar nonlinear difference equations with delay is considered. Sufficient conditions for the global asymptotic stability of a unique equilibrium are given. Applications in economics and other fields lead to consideration of associated optimal control problems. An optimal control problem of maximizing a consumption functional is stated. The existence of optimal solutions is established and their stability (the turnpike property) is proved. (Received January 30, 2012)

41 ► *Approximations and expansions*

1080-41-159 **Tatyana Sorokina*** (tsorokina@towson.edu), Towson University, Department of Mathematics, 8000 York Road, Towson, MD 21252. *Intrinsic supersmoothness of multivariate splines.*

A multivariate spline is a piecewise polynomial in several variables defined on some simplicial partition of a polyhedral domain. The polynomial pieces are joined together along the faces of the partition to ensure some degree of required global smoothness. We show that many spaces of multivariate splines possess additional smoothness (supersmoothness) at certain faces. This type of additional smoothness is neither imposed explicitly nor is reflected in the standard description of these spaces. This phenomenon affects the dimension and interpolating properties of splines spaces. The supersmoothness is caused by certain geometric properties of the underlying partition. (Received January 23, 2012)

1080-41-228 **Azita Mayeli***, amayeli@qcc.cuny.edu. *Shift-invariant subspaces for the Heisenberg group.* In this talk we introduce the concept of shift-invariant subspaces in L^2 of the Heisenberg group and study their structure in terms of the group Fourier transform. We apply the results to the characterization of frames and Riesz bases for these subspaces. We also extend these results to advanced settings, namely, simply connected nilpotent Lie groups whose irreducible representations mod the center are *square-integrable*. This is a joint work with Bradley Currey and Vignon Oussa of St. Louis University. (Received January 28, 2012)

1080-41-307 **R. N. Mohapatra*** (ram.mohapatra@ucf.edu), Department of Mathematics, 4000 Central Florida Blvd., Orlando, FL 32817. *Degree of Approximation of Lupas Operators at points of discontinuity.*

Recently there has been studies of degree of approximation of functions by Bernstein polynomials at a point where there is jump discontinuity. In this paper we study the degree of approximation by Lupas operators. The research is in progress for Meyer-konig and Zeller operators. (Received January 30, 2012)

42 ► *Fourier analysis*

1080-42-27 **Matthew Fickus*** (Matthew.Fickus@afit.edu). *Constructing all finite unit norm tight frames.*

Given $M \leq N$, a corresponding finite unit norm tight frame (UNTF) is a maximally-orthogonal collection of N unit vectors in M -dimensional Euclidean space, where orthogonality is measured in terms of the Hilbert-Schmidt norm of the Gram matrix. UNTFs arise in several applications, and are known to exist for any $M \leq N$. Indeed, ideas from differential geometry have been used to show that an infinite number of distinct UNTFs exist (even modulo rotations) whenever $N > M + 1$. However, up to this point, only a handful of explicit constructions of such frames have been found. In this talk, we present a new explicit construction method which produces every UNTF. The main idea is to parameterize a UNTF in terms of its eigensteps, namely the interlacing sequence of spectra of its partial frame operators. (Received December 12, 2011)

1080-42-78 **Palle Jorgensen*** (palle-jorgensen@uiowa.edu), Dept mathematics, MLH, University of Iowa, Iowa City, IA, **Keri Kornelson**, OK, and **Karen Shuman**, IA. *Selfsimilar operator fractas.* Preliminary report.

Co-authors Dorin Dutkay, Keri Kornelson, and Karen Shuman: We report on new results in an orthogonal harmonic analysis of selfsimilar measures, such as arise in dynamical systems and in fractal theory: Representations of Cuntz algebras are shown to reflect selfsimilarity, and in determine both the algorithmic and the analytic part of the problem. Here for measures we define selfsimilarity relative to a prescribed finite family of affine transformations. Cuntz algebras are infinite algebras on a finite number of generators, and on certain relations. By their nature, they are selfsimilar and they therefore ideally serve to encode iterated function systems (IFSs) and their measures. At the same time, their representations offer (in a more subtle way) a new harmonic analysis of IFS-fractal measures. We show that there is a unitary scaling operator U whose spectrum determines key features. We show that the operator U has a number of explicit properties which justify the name “selfsimilar operator fractal.” (Received January 10, 2012)

1080-42-79 **Dorin Ervin Dutkay*** (ddutkay@gmail.com), Orlando, FL 32816. *Fourier frames.*

We present the concept of Fourier frames, an extension of the notions of spectrum for a measure, or of Plancherel results. We show how Fourier frames are related to frames of exponential functions, talk about their Beurling

dimension and give some detailed descriptions in the case of absolutely continuous measures. (Received January 10, 2012)

1080-42-81 **Christopher Heil*** (heil@math.gatech.edu), School of Mathematics, Georgia Tech, Atlanta, GA 30032-0160, **Alex M. Powell** (alexander.m.powell@vanderbilt.edu), Department of Mathematics, Vanderbilt University, Nashville, TN 37240, and **Ramazan Tinaztepe** (rtinaztepe@gmail.com), Department of Mathematics, Alabama A&M University, Normal, AL 35762. *Modulation Spaces, BMO, BLT, and Rectangular Partial Sums.*

The modulation spaces quantify the time-frequency concentration of functions and distributions. We relate the modulation spaces, the space BMO of functions with bounded mean oscillation, and the Balian–Low Theorem. The embedding of modulation spaces into VMO (the space of functions of vanishing mean oscillation) is seen to lie behind the essential limitation of the time-frequency localization of Gabor systems that form Riesz bases. We also prove that a type of Balian–Low Theorem holds for Gabor Schauder bases, which raises interesting questions about the convergence of rectangular partial sums of Fourier series in higher dimensions. (Received January 10, 2012)

1080-42-113 **Qiyu Sun***, Department of Mathematics, University of Central Florida, Orlando, FL 32816. *Nonlinear Wiener’s lemma and its application to a sampling problem.* Preliminary report.

In this talk, I will discuss Wiener’s lemma for strictly monotone functions and its application to reconstructing signals with finite rate of innovations from their nonlinear samples. (Received January 18, 2012)

1080-42-190 **Marcin Bownik** and **Darrin Speegle*** (speegled@slu.edu). *The HRT Conjecture for certain rapidly decaying functions.* Preliminary report.

The HRT Conjecture states that the time-frequency shifts of an arbitrary L^2 function are linearly independent. Most results have focused on describing subsets of the time-frequency plane such that shifts from that subset of an arbitrary L^2 function are linearly independent. In this work, we study functions such that arbitrary time-frequency shifts of those functions are linearly independent. Criteria related to support and decay are given so that all functions satisfying those criteria have linearly independent time-frequency shifts. As a typical type of example of our results, we can show that $P(x)e^{|x|^{1+\epsilon}}$ has linearly independent time-frequency shifts whenever P is a polynomial and $\epsilon > 0$. Several open problems related to our approach will also be mentioned. (Received January 26, 2012)

1080-42-201 **Yang Wang*** (Ywang@math.Msu.edu), 5228 Madison ave, A5, Okemos, MI 48864. *Edge Detection from Truncated Fourier Data.*

Edge detection from a finite number of Fourier coefficients is challenging as it requires extracting local information from global data. The problem is exacerbated when the input data is noisy since accurate high frequency information is critical for detecting edges. The noise furthermore increases oscillations in the Fourier reconstruction of piecewise smooth functions, especially near the discontinuities. In this talk we discuss a technique that allows us to accurately detect discontinuities of a compactly supported piecewise smooth functions from its truncated Fourier coefficients. (Received January 27, 2012)

1080-42-205 **Kasso A Okoudjou*** (kasso@math.umd.edu), Mathematics Building, University of Maryland, College Park, MD 20742, and **Jakob Lemvig** and **Christopher Miller**. *Prime tight frames.* Preliminary report.

We introduce a class of finite tight frames called prime tight frames and prove some of their elementary properties. In particular, we show that every finite tight frame with redundancy less than 2 is prime. Moreover, we prove that any finite tight frame can be written as a finite union of prime ones. Finally, we construct families of prime tight frames from cyclic, harmonic, spectral tetris, and equiangular tight frames. (Received January 27, 2012)

1080-42-249 **Veronika Furst*** (furst_v@fortlewis.edu), Department of Mathematics, Fort Lewis College, 1000 Rim Drive, Durango, CO 81301, and **Erich A. McAlister** (mcAlister_e@fortlewis.edu), Department of Mathematics, Fort Lewis College, 1000 Rim Drive, Durango, CO 81301. *The path-connectedness of MRA equivalence classes.* Preliminary report.

Papadakis, Stavropoulos, and Kalouptsidis define the unitary equivalence of multiresolution analyses in $L^2(\mathbb{R})$. In this talk, we show that given any two unitarily equivalent MRAs $\{V_j\}$ and $\{V'_j\}$, there exists a strongly continuous path of unitary operators U_t such that $U_0(\{V_j\}) = \{V_j\}$, $U_1(\{V_j\}) = \{V'_j\}$, and for each $t \in [0, 1]$, $U_t(\{V_j\})$ is equivalent to $\{V_j\}$.

Extension of this result to generalized multiresolution analyses, using GMRA equivalence defined by Baggett, Furst, Merrill, and Packer, will be discussed. (Received January 29, 2012)

43 ► *Abstract harmonic analysis*

1080-43-74 **Lawrence W. Baggett*** (lawrence.baggett@colorado.edu). *Multiresolution Analysis and the Mackey Machine*. Preliminary report.

Implicit in the notion of a multiresolution analysis is a group of translation operators and a dilation operator. The group generated by these operators is the range of a unitary representation of the so-called wavelet group $G = \mathbb{Q}_N \rtimes \mathbb{Z}$. We discuss the question of which representations of the wavelet group support an MRA. Examples will be given of some that do and some that do not. In the end, we give a theorem that describes precisely which ones do. (Received January 09, 2012)

1080-43-88 **John J Benedetto*** (jjb@math.umd.edu), Norbert Wiener Center, Department of Mathematics, University of Maryland, College Park, MD 20742. *Sparse solutions of number-theoretic Gabor equations*. Preliminary report.

The discrete narrow band ambiguity function of a sequence $u(p)$ of prime length p is proven to have the smallest possible upper bound $B(p)$ off the dc-component of the discrete time-Doppler plane. The sequence $u(p)$ was constructed by Goran Bjorck, and it is used to construct a discrete Gabor frame $G(u(p))$. Because of $B(p)$, the sparsest solution x of $G(u(p))x = b$ can be computed by orthogonal matching pursuit. The relevance of this process is explained in the context of transform-based image compression. (Received January 11, 2012)

1080-43-106 **Josh MacArthur*** (joshm@mathstat.dal.ca), Dept. of Mathematics & Statistics, Dalhousie University, Halifax, NS B3H 4R2, Canada, and **Keith F Taylor** (kft@mathstat.dal.ca), Dept. of Mathematics & Statistics, Halifax, NS B3H 4R2, Canada. *Wavelets with Crystal Symmetry Shifts*.

We introduce and explore the concept of wavelets when the lattice of shifts is replaced by a discrete group of measure preserving affine transformations of Euclidean space. This allows for all crystal symmetry groups to play the role of shifts, even the nonsymmorphic groups which cannot be handled with the existing theory of wavelets with composite dilations. Two-dimensional examples will be presented. (Received January 16, 2012)

1080-43-135 **Michael J. Puls*** (mpuls@jjay.cuny.edu), Department of Mathematics, John Jay College-CUNY, 445 West 59th Street, New York, NY 10019. *Discrete Groups and Pompeiu's Problem*.

Let X be a Riemannian manifold admitting a transitive group G of isometries. Denote by μ the volume measure on X . A finite collection \mathcal{K} of compact subsets of X is said to have the *Pompeiu property* with respect to G if

$$\int_{gK} f d\mu = 0 \text{ for all } K \in \mathcal{K} \text{ for all } g \in G$$

implies that $f = 0$ whenever f is a continuous function on X . The Pompeiu problem asks the following: What conditions will guarantee that \mathcal{K} possess the Pompeiu property. In this talk we will give some recent results concerning this question for abelian groups and free groups. (Received January 20, 2012)

1080-43-185 **Kathy D. Merrill*** (kmerrill@ColoradoCollege.edu). *Simple wavelet sets*. Preliminary report.

New examples will be presented of wavelet sets in \mathbb{R}^2 that are finite unions of convex sets, with possible generalizations to \mathbb{R}^3 . (Received January 26, 2012)

1080-43-229 **Jens Gerlach Christensen*** (jens.christensen@tufts.edu), **Azita Mayeli** and **Gestur Ólafsson**. *Besov spaces on stratified Lie groups and atomic decomposition through representation theory*.

Stratified Lie groups come equipped with a natural notion of dilation which can be used to obtain a wavelet theory in this setting. Recently Führ and Mayeli defined homogeneous Besov spaces on stratified Lie groups via the spectral theory for the sub-Laplacian. In this talk we will describe these spaces using the quasi-regular representation, and we further show how our results can be used to provide atomic decompositions.

This is joint work with Azita Mayeli and Gestur Ólafsson. (Received January 28, 2012)

1080-43-299 **Palle Jorgensen, Keri Kornelson and Karen Shuman***, shumank@math.grinnell.edu.
Some properties of an operator-fractal.

This talk will introduce a family of unitary operators on the fractal Cantor Hilbert space $L^2(\mu_{\frac{1}{4}})$, where $\mu_{\frac{1}{4}}$ is the equilibrium measure associated with scale $\frac{1}{4}$. We will explore some surprising properties of one particular operator in this family, including its fractal nature. (Received January 30, 2012)

44 ► *Integral transforms, operational calculus*

1080-44-320 **Ajay Kumar Shukla*** (ajayshukla2@rediffmail.com), Department of Applied Mathematics, S.V.National Institute of Technology, Ichchhanath, Surat, Gujarat 395 007, India, and **Ibrahim A Salehbhai** (ibrahimmaths@gmail.com), Department of Applied Mathematics, S.V.National Institute of Technology, Surat, Gujarat 395 007, India. *Recent Developments in Laguerre Transform.* Preliminary report.

Josheph McCully wrote a remarkable paper on Laguerre transform [SIAM Rev.Vol2 No.3, July 1960] and same year Debnath also gave Laguerre Transform [Bull. Calcutta Math. Soc. 55 (1960), pp.69–77.]. In present paper, we discuss the extension of Laguerre Transform and some of its basic properties. The solution of certain partial differential equations may also be possible by applying this technique. (Received January 31, 2012)

46 ► *Functional analysis*

1080-46-25 **Deguang Han***, Department of Mathematics, University of Central Florida, Orlando, FL 32816. *Wavelet frames for (not necessarily reducing) affine subspaces.*

An affine subspace is a closed subspace of $L^2(R)$ that is generated by applying the dilation operators to a shift-invariant subspace. An affine subspace quite often is not a reducing subspace with respect to both dilation and translation operators. In this talk we will discuss some results about the generator problem, existence of wavelet frames and some structural properties for affine subspaces. This is a joint work with Q. Gu. (Received November 21, 2011)

1080-46-33 **Yue Fan**, Department of Mathematics and Statistics, Program in Bioinformatics, Boston University, Boston, MA 02215, **Shinuk Kim**, Program in Bioinformatics, Boston University, Boston, MA 02215, **Mark A Kon**, Department of Mathematics and Statistics, Program in Bioinformatics, Boston University, Boston, MA 02215, **Louise A Raphael*** (lraphael@howard.edu), Department of Mathematics, Howard University, Washington, DC 20059, and **Charles DeLisi**, Program in Bioinformatics, Boston University, Boston, MA 02215. *Functional Analytic Methods for Gene Expression Denoising.*

We prove results on two denoising methods: local averaging and kernel regression on graphs, adapted from methods in Euclidean space. A particular property of Euclidean denoising which carries over is that the accuracy of the denoised function increases to a maximum as a function of the denoising parameter and then decreases.

Our approach interprets a feature vector as a function on its set of indices, and using a graph or metric structure on the index set to smooth this function. This approach is illustrated for gene expression feature vectors derived from benchmark cancer data sets, where indices are gene sets with natural structures. (Received December 06, 2011)

1080-46-199 **Geoff Diestel** (gdiestel@ct.tamus.edu), 1901 South Clear Creek Road, Killeen, TX 76549, and **Ralph Howard*** (howard@math.sc.edu), University of South Carolina, Department of Mathematics, Columbia, SC 29208. *Restrictions on linear isomorphisms between spaces of smooth functions on compact manifolds.* Preliminary report.

Let M be a smooth compact Riemannian manifold. For a real number s the order s Sobolev norm on $C^\infty(M)$ is $\|u\|_s = \left(\int_M (I + \Delta)^{s/2} u)^2 dV \right)^{1/2}$ where Δ is the Laplacian on M with positive semi-definite choice of sign and dV is the volume measure. If N is another smooth compact Riemannian manifold a linear map $R: C^\infty(M) \rightarrow C^\infty(N)$ is of *finite order* iff there is a constant k so that for all s there is a constant C_s with $\|Ru\|_s \leq C_s \|u\|_{s+k}$.

Theorem *If $R: C^\infty(M) \rightarrow C^\infty(N)$ is a linear isomorphism so that both R and R^{-1} have finite order, then $\dim M = \dim N$.*

This result is a start on explaining why the isomorphism theorems of integral geometry are always between space of functions on manifolds of the same dimension. (Received January 26, 2012)

1080-46-220 **Deguang Han** and **David R. Larson*** (larson@math.tamu.edu), Department of Mathematics, Texas A&M University, College Station, TX 77843, and **Bei Liu** and **Rui Liu**. *Operators, wavelets and frames.*

We develop a general dilation theory for operator-valued measures. This completely generalizes the known dilation theory for frames. Moreover our methods extend to obtain new dilation results for maps between operator algebras. (Received January 27, 2012)

49 ► *Calculus of variations and optimal control; optimization*

1080-49-7 **Peng Liu*** (pliu19@jhu.edu) and **Tim Leung**. *Risk Premia and Optimal Liquidation of Defaultable Securities.*

This paper studies the optimal timing to liquidate credit derivatives in a general intensity-based credit risk model under stochastic interest rate. We incorporate the potential price discrepancy between the market and derivative holder, which is characterized by risk-neutral valuation under different default risk premia specifications. To quantify the value of optimally timing to sell, we introduce the *delayed liquidation premium* which is closely related to the stochastic bracket between the market price and the state price deflator. We also provide mathematical characterization and financial explanations for the optimal liquidation policy. Furthermore, we examine the optimal buy-and-sell strategy by studying an optimal double-stopping problem. Numerical examples are provided to illustrate the optimal strategies for various credit derivatives. (Received September 13, 2011)

1080-49-19 **Jafar - Zafarani*** (jzaf@zafarani.ir), Department of Mathematics, Sheikhabaee University and University of Isfahan, 81745-163 Isfahan, Isfahan, Iran. *Generalized Minty vector variational-like inequalities and vector optimization problems in Asplund spaces.*

We consider two generalized Minty vector variational-like inequalities and investigate the relations between their solutions and vector optimization problems for non-differentiable α -invex functions. (Received December 27, 2011)

1080-49-62 **Francisco Facchinei** and **Andreas Fischer*** (Andreas.Fischer@tu-dresden.de), Institute of Numerical Mathematics, TU Dresden, Dresden, 01062, and **Markus Herrich**. *A New Local Framework for Constrained Smooth and Nonsmooth Equations.*

The problem of solving a system of equations, possibly subject to convex constraints, appears in several applications. For example, Karush-Kuhn-Tucker conditions are frequently written in this way. A new iterative framework for solving constrained equations is presented. Local superlinear convergence results of algorithms within the framework are derived under an error bound condition. This enables the application to problems with nonisolated solutions. (Received January 01, 2012)

1080-49-126 **Ihsan A. Topaloglu*** (itopalog@indiana.edu). *An Isoperimetric Problem with Long-Range Interactions.*

In this talk I will analyze a nonlocal isoperimetric problem (NLIP) that arises as the sharp interface limit of an energy modeling the phase separation of diblock copolymers. First, I will consider the NLIP on the two dimensional sphere and characterize the global minimizer when the parameter controlling the influence of the nonlocality is small. Furthermore, I will demonstrate stability/instability results of certain critical points depending on where in the parameter regime one looks. Time permitting, I will introduce a variant of the NLIP defined on the three dimensional Euclidean space and mention challenges and interesting consequences the unbounded domain harbors. This is a joint work with Peter Sternberg. (Received January 20, 2012)

1080-49-134 **Gabor Pataki*** (gabor@unc.edu), Dept of Statistics and Operations Research, UNC Chapel Hill, Chapel Hill, NC 27599. *Bad semidefinite programs: they all look the same, part 2.* Preliminary report.

A conic linear system P is called badly behaved, if for some objective function " c " the supremum of " cx " over P is finite, but the dual program does not have a solution that attains the same value.

This talk focuses on aspects of the paper <http://arxiv.org/abs/1112.1436> not covered previously in talks, and on the paper http://www.optimization-online.org/DB_HTML/2011/09/3180.html.

Precisely, we will describe a general geometric "sandwich theorem" to characterize well, or badly behaved conic systems. It unifies and generalizes two seemingly unrelated classical conditions: polyhedrality, and Slater's

condition, and becomes particularly simple, when the underlying cone is "nice". When the underlying cone is the semidefinite, second order, a p-cone, or a direct product of these, it leads to combinatorial type characterizations.

We will also look at the connection of facially exposed and nice cones, and show that these classes of cones are surprisingly closely related. In particular, we show that niceness implies facial exposedness; in reverse, facial exposedness with an added technical condition implies niceness. (Received January 20, 2012)

51 ► Geometry

1080-51-43 **Scott Provan*** (Scott_Provan@UNC.edu), Dept. of Statistics and Operations Research, CB#3260, University of North Carolina, Chapel Hill, NC 27599, and **Marcus Brazil, Doreen Thomas** and **Jia Weng**. *Minimum Beam Detectors for Polygonal Regions*.

We study the problem of finding, for any polygonally-bounded convex set S in the plane, the minimum length of a set F that is guaranteed to intersect any straight line passing through S . This has application to situations involving searching for straight line objects or blocking straight-line passage across a region. As simple as it sounds, this problem is almost completely unsolved and remarkably difficult. We provide a framework and some fundamental results for understanding the properties of minimum beam detectors — including the close connection of this problem to the Steiner tree problem — as well as some surprising examples of proposed minimum beam detectors. (Received December 13, 2011)

1080-51-92 **Pedro A Solorzano*** (solorzano@member.ams.org). *A metric manifestation of holonomy*. Preliminary report.

The failure to have a well-defined global notion of parallelism lead to the introduction of the notion of holonomy. A transformation a in the riemannian holonomy group at a given point p is a linear map on the tangent space at p resulting from parallel translation along a loop γ based at the point p . The existence of such γ is the defining characteristic of a .

Following Richard Montgomery, the process is reversed by assigning to each transformation a the length of the shortest loops γ (or the infimum of the lengths of loops) that generate a by parallel translation. This procedure yields a natural additional structure to the holonomy groups; this structure is sometimes different from the usual Lie group one.

An immediate application comes from looking at the evolution of tangent bundles given an evolution of the base spaces (both à la Gromov). The interplay of these notions and that of curvature is also investigated. (Received January 12, 2012)

1080-51-132 **Rik Sarkar, Xiaotian Yin, Jie Gao** and **Feng Luo*** (fluo@math.rutgers.edu), 110 Frelinghuson Road, Piscataway, NJ 08854, and **David Gu**. *Greedy Routing with Guaranteed Delivery Using Ricci Flows*.

We use Ricci flow to convert a sensor field network with holes such that all the holes are circular — greedy forwarding will (Received January 20, 2012)

1080-51-270 **Michael Munn*** (munnm@missouri.edu), Mathematics Department, University of Missouri, Columbia, MO 65201. *An excess estimate for Alexandrov spaces and applications*.

The excess estimate was introduced by Abresch-Gromoll in 1990 and has provided a useful tool in analyzing the structure of Riemannian manifolds with a lower Ricci curvature bound. Here we present a generalized version of this excess estimate for n -dimensional Alexandrov spaces equipped with a measure satisfying an infinitesimal Bishop-Gromov volume comparison condition. As an application, we show how this estimate can be used to extend well-known results from classical Riemannian geometry to this more general class of metric measure spaces. (Received January 30, 2012)

1080-51-285 **Frederick R. Cohen, Rafal Komendarczyk*** (rako@tulane.edu) and **Clayton Shonkwiler**. *On the injectivity of the κ -invariant for homotopy links*. Preliminary report.

A parametrization of an n -component link in R^3 , produces a natural evaluation map from the n -torus to the configuration space of n distinct points in R^3 . Denote by κ the map from homotopy links to the set of homotopy classes of evaluation maps. A natural conjecture arises, that κ classifies homotopy links. Koschorke first proved that κ has this property for homotopy Brunnian links. In this talk, I will show how to recast Koschorke's correspondence in the language of torus homotopy groups, which reveals an interesting algebraic structure. Further, time permitting, I will describe progress towards extending the result beyond the Brunnian case. (Received January 30, 2012)

1080-51-372 **David Gu*** (gu@cs.sunysb.edu), David Gu, 1 Newcastle Ave, Plainview, NY 11803, and **Jie Gao** and **Feng Luo**. *Ricci flow in Wireless Sensor Networks*.

Ricci flow in geometric analysis is an effective tool to design Riemannian metrics according to prescribed curvatures. Ricci flow can be generalized to the graph setting. This work introduces applications of Ricci flow on wireless sensor networks to tackle fundamental problems in networking, such as routing, load balancing, and localization and so on. (Received January 31, 2012)

52 ► *Convex and discrete geometry*

1080-52-39 **Zokhrab Mustafaev*** (mustafaev@uhcl.edu), 2700 Bay Area Blvd, Houston, TX 77058, and **Horst Martini** (horst.martini@mathematik.tu-chemnitz.de), University of Technology Chemnitz, 09107 Chemnitz, Germany. *One the unit ball and isoperimetrix in Minkowski spaces*. Preliminary report.

One of the challenging open problems of Minkowski Geometry is that whether the unit ball must be an ellipsoid if it is a solution of the isoperimetric problem for higher-dimensional Minkowski spaces. For $d=2$, apart from ellipses, the Radon curves have that property as well. In this talk, we discuss this problem for the Holmes-Thompson and Busemann measures in higher-dimensional Minkowski spaces. (Received December 12, 2011)

1080-52-42 **gabor toth*** (gtoth@camden.rutgers.edu), Department of Mathematics, Rutgers University, Camden, NJ 08102. *Characterization of Simplices via Measures of Symmetries*. Preliminary report.

Measuring how far an n -dimensional convex body L is from an n -simplex, the interior of the convex body naturally splits into a regular and singular set. A detailed study of examples leads to the conjecture that the simplex is the only convex body with no singular points. We prove this conjecture in two specific situations: (1) L has at least n isolated extreme points; (2) There is a flat point on the boundary of L . (Received December 13, 2011)

1080-52-44 **Valeriu Soltan*** (vsoltan@gmu.edu), 4400 University Drive, MS 3F2, Fairfax, VA 20191. *Convex surfaces in \mathbb{R}^n with hyperplanar shadow-boundaries*. Preliminary report.

We describe the convex surfaces in \mathbb{R}^n , possibly unbounded, whose shadow-boundaries with respect to parallel illumination satisfy certain hyperplanarity conditions. (Received December 14, 2011)

1080-52-103 **Horst Martini*** (martini@mathematik.tu-chemnitz.de), Faculty of Mathematics, University of Technology in Chemnitz, 09107 Chemnitz, Germany. *Minsum k -flats and minsum hyperspheres in normed spaces*.

Given a finite set of m points (with positive weights) in an n -dimensional normed space, find k -dimensional flats having minimal sum of (weighted) distances to these given points. This class of problems contains the famous Fermat-Torricelli problem ($k = 0$) and the minsum hyperplane problem ($k = n - 1$). As a variant of the latter, we also consider minsum hyperspheres being optimal with respect to the given point set. In this talk, old and new results on these problems will be presented. (Received January 16, 2012)

1080-52-108 **J. Gubeladze** and **Jack Edward Love*** (jack.eddie.love@gmail.com), 1878 Market St., Apt. 202, San Francisco, CA 94102. *Hom-polytopes between regular polytopes*. Preliminary report.

Hom-polytopes are the polytopes of affine maps between two convex polytopes. Their study is motivated by categorical analysis of polytopes—a recent trend in this classical part of geometry. First steps towards a systematic theory were recently undertaken by Bogart-Contois-Gubeladze. Currently our understanding is very limited even in the case of regular source and target polygons. We report on our joint ongoing project with J. Gubeladze on the hom-polytopes between higher dimensional regular polytopes. Counting their vertices is a blend of combinatorial, geometric, and arithmetic challenges. (Received January 17, 2012)

1080-52-139 **Egon Schulte*** (schulte@neu.edu), Northeastern University, Department of Mathematics, Boston, MA 02115. *Symmetric Graphicalahedra*.

Given a connected graph G with p vertices and q edges, the G -graphicalahedron is a vertex-transitive simple abstract polytope of rank q whose edge graph is isomorphic to a Cayley graph of the symmetric group S_p associated with G . The G -graphicalahedron is a generalization of the well-known permutahedron obtained when G is a path. Graphicalahedra inherit their combinatorial symmetries from those of the underlying graphs. When G is a q -cycle, the G -graphicalahedron is intimately related to the geometry of the infinite euclidean Coxeter group

\tilde{A}_{q-1} and can be viewed as an edge-transitive tessellation of the $(q-1)$ -torus by $(q-1)$ -dimensional permutahedra, obtained as a quotient, modulo the root lattice A_{q-1} , of the Voronoi tiling for the dual root lattice A_{q-1}^* in euclidean $(q-1)$ -space. This is joint work with M.Rio-Francos, I.Hubard and D.Oliveros. (Received January 21, 2012)

1080-52-161 **Robert J. MacG. Dawson*** (rdawson@cs.stmarys.ca), Dept of Mathematics and Computing Science, Saint Mary's University, Halifax, NS B3H 3C3, Canada. *Monotone spreads of compact convex sets*. Preliminary report.

By a *hyperspace* we shall mean a metric space, the points of which are compact convex sets in \mathbf{R}^d . (We may restrict our attention to, *e.g.*, convex bodies or strictly convex sets.) Such a space also has a linear structure given by scaling and the Minkowski sum. The Hausdorff "max-min" metric gives particularly interesting hyperspaces. In particular, the problem of determining which sets have the Čebyšev nearest-neighbor property is surprisingly difficult.

In a 2010 *Jour. Geom* paper, the speaker introduced *monotone arcs* of bodies in hyperspaces, parametrized arcs such that, in any direction, either the support function is a monotone function of the parameter or the support points are disjoint. Such arcs have the Čebyšev property under fairly weak additional conditions. In this talk, we will look at *monotone spreads*, collections of convex bodies such that every two are joined within the spread by a monotone arc. We will see that these too yield examples of Čebyšev families, including some with dimension higher than any finite-dimensional examples previously known. There is a surprising tie-in with the work of Radon, Adams, and others on linear spaces of nonsingular matrices. (Received January 24, 2012)

1080-52-178 **Carl W. Lee*** (lee@ms.uky.edu), Department of Mathematics, University of Kentucky, Lexington, KY 40506. *The cd-indices, CD-vectors, and h-vectors of convex polytopes*. Preliminary report.

We will discuss connections between the **cd**-index for convex polytopes, the *CD*-vector of Jonathan Fine, and the toric *h*-vector. In particular, we will discuss formulas for converting from one to another, ways to compute them by sweeping the polytope with a hyperplane, and why the *CD*-vector is especially nice for simple polytopes. (Received January 25, 2012)

1080-52-183 **Alina Stancu*** (stancu@mathstat.concordia.ca), Department of Mathematics and Statistics, Concordia University, Montreal, Quebec H3G1M8, Canada. *On the search of new affine invariants for convex bodies*.

We will present a method of producing equi-affine invariant quantities for smooth convex bodies in \mathbb{R}^n and some of its applications. We will show a direction in which this method is extended to other classes of convex bodies with the purpose of obtaining new $SL(n)$ -invariants and new isoperimetric type inequalities relating them. (Received January 26, 2012)

1080-52-184 **Andras Bezdek, Włodzimierz Holsztynski and Włodzimierz Kuperberg*** (kuperw1@auburn.edu), Department of Mathematics and Statistics, Auburn University, Auburn, AL 36849-5310. *Small containers for large families of sets*. Preliminary report.

How small can the area of a compact subset of the plane (a *container*) be if it contains a circle of every radius between 0 and 1? It is known that such a compact container can be nowhere dense: Holsztynski, Kuperberg, and Mycielski [MR0461433 (57 #1418)] obtained a much more general result, implying that in \mathbb{R}^n there exists a compact nowhere dense set that contains a translate of the boundary of every convex set of diameter $d \leq 1$. However, the question of small-area containers has not been addressed before. We present an upper bound on the minimum area of a container for circles and we discuss a number of questions for families of sets of various shapes. (Received January 26, 2012)

1080-52-194 **Deborah Oliveros*** (dolivero@matem.unam.mx), Instituto de Matemáticas, UNAM, Area de la Investigación Científica, Circuito Exterior C.U., 04510 Mexico City, Mexico. *About piercing numbers of affine planes, lines and intervals*. Preliminary report.

In this talk we will see an interesting family of r -hypergraphs with the property, that the chromatic number is bounded from above by a function of its clique number. Bounds, that allows us to find the piercing numbers of some families of affine hyperplanes. (Received January 26, 2012)

- 1080-52-216 **Konrad J Swanepoel*** (k.swanepoel@lse.ac.uk), Department of Mathematics, London School of Economics, Houghton Street, London, WC2A 2AE, England. *Double normals in the plane and on the sphere*. Preliminary report.
- Martini and Soltan (2005) introduced the notion of a *double normal* of a finite set S of points: a pair $p, q \in S$ such that each point of S lies between or on the hyperplanes perpendicular to pq that pass through p and q . This notion lies between the well studied concepts of diameter pairs and antipodal pairs of a finite set of points.
- We investigate the problem of determining the maximum number of double normal pairs in a set of n points in Euclidean space. We show that a set of $n \geq 3$ points in the plane has at most $3\lfloor n/2 \rfloor$ double normals, which is sharp for each n . We find examples of n points in 3-space with $\frac{17}{4}n - O(\sqrt{n})$ double normals. These examples all lie on a 2-sphere. Finally, we show that any set of n points on a 2-sphere has at most $\frac{17}{4}n - 6$ double normals, a bound that is sharp for infinitely many values of n . (Received January 27, 2012)
- 1080-52-247 **Jim Lawrence*** (lawrence@gmu.edu). *When is the product of two Davis matrices a Davis matrix?* Preliminary report.
- A matrix is called a *Davis matrix* if the set of nonnegative elements of the linear space spanned by its columns coincides with the cone generated by its columns. The question of the title is of interest with respect to the problem of finding the sections and projections of a cone. (Received January 29, 2012)
- 1080-52-259 **Karoly Bezdek*** (bezdek@math.ucalgary.ca), Calgary, Alberta T2N 1N4, Canada. *On foams with convex cells each containing a unit ball*.
- We raise and investigate the following problem that one can regard as a very close relative of the densest sphere packing problem. If the Euclidean 3-space is partitioned into convex cells each containing a unit ball, how should the shapes of the cells be designed to minimize the average surface area of the cells? (Received January 29, 2012)
- 1080-52-273 **Seung Jin Lee*** (lsjin@umich.edu), 1875 Pointe Crossing Apt# 101, Ann Arbor, MI 48105, and **Alexander Barvinok** and **Isabella Novik**. *Centrally symmetric polytopes with many faces*.
- We consider the convex hull \mathcal{B}_k of the symmetric moment curve $U_k(t) = (\cos t, \sin t, \cos 3t, \sin 3t, \dots, \cos(2k-1)t, \sin(2k-1)t)$ in \mathbb{R}^{2k} , where t ranges over the unit circle $\mathbb{S} = \mathbb{R}/2\pi\mathbb{Z}$. The curve $U(t)$ is locally neighborly: as long as t_1, \dots, t_k lie in an open arc of \mathbb{S} of a certain length $\phi_k > 0$, the convex hull of the points $U(t_1), \dots, U(t_k)$ is a face of \mathcal{B}_k . We characterize the maximum possible length ϕ_k , proving, in particular, that $\phi_k > \pi/2$ for all k . This allows us to construct centrally symmetric polytopes with a record number of faces. In this talk, I will present how to construct a d -dimensional centrally symmetric polytope with about $3^{d/4}$ vertices such that every pair of non-antipodal vertices of P spans an edge of P . (Received January 30, 2012)
- 1080-52-279 **Shigeki Akiyama*** (akiyama@math.sc.niigata-u.ac.jp), Faculty of Science, Niigata University, Ikarashi-2 8050, Niigata, 950-2181, Japan. *Revisit aperiodic tiles of Ammann*.
- A tile is a compact set which is a closure of its interior. We consider planar tilings given by a set of tiles under rigid motion. A finite set of tiles is called ‘aperiodic’ if it admits a planer tiling but any of such tilings is non-periodic. Motivated by Socolar-Taylor’s hexagon, we discuss a simple marking of a variant of Ammann tiles. It is challenging to generalize this construction to some rep-tiles, whether it leads to an easy construction of a new aperiodic monotile. (Received January 30, 2012)
- 1080-52-280 **Gábor Fejes Tóth*** (gfejes@renyi.hu). *Convex Sets in Empty Convex Position*. Preliminary report.
- We investigate the following variant of the empty n -gon problem of Erdős. Let \mathcal{F} be a family of disjoint compact convex sets. A sub-family $\mathcal{F} \subset \mathcal{F}$ is in *convex position* if no member $A \in \mathcal{F}$ is contained in the convex hull of the union of the sets belonging to $\mathcal{F} \setminus \{A\}$. \mathcal{F} is in *empty convex position in \mathcal{F}* if it is in convex position and the convex hull of the union of its members does not contain any member of $\mathcal{F} \setminus \mathcal{F}$. We show that for any integers $k \geq 4$ and $n \geq k$ there is an integer N such that any family of more than N disjoint compact convex sets with the property that any k members of it are in convex position has n members that are in empty convex position in the family. (Received January 30, 2012)
- 1080-52-232 **Ferenc Fodor*** (fodorf@math.u-szeged.hu), Bolyai Institute, University of Szeged, Aradi vertanuk tere 1, Szeged, H-6720. *On properties of convex disc-polygons*. Preliminary report.
- We will consider convex disc-polygons in the plane, that is, intersections of finite families of closed unit discs. The main goal is to examine how well such disc-polygons can approximate certain classes of convex sets. We will especially concentrate on the case when the disc-polygons are generated randomly according to the uniform

probability model. We will describe the asymptotic behaviour of certain key geometric properties of such polygons under various smoothness conditions of the convex set being approximated.

This talk contains joint results with P. Kevei (University of Szeged) and V. Vigh (University of Szeged). (Received January 31, 2012)

1080-52-341 **T. Bisztriczky***, 2500 University Drive NW, Calgary, Alberta T2N 1N4, Canada, **K. Boroczky**, Budapest, Hungary, and **A. Heppes**, Budapest, Hungary. *The $T(5)$ Property of Families of Overlapping Unit Disks*. Preliminary report.

We consider a finite family F of unit disks in the plane with the properties: $T(k)$: Any k -element subfamily of F has a (line) transversal, and $O(d)$: The distance between the centres of any two elements of F is greater than d . It is wellknown that F has a transversal in each of the following cases: $k=3$ and $d=2\sqrt{2}$ (sharp), $k=4$ and $d=4/\sqrt{3}$ (sharp) and $k=5$ and $d=2$. In this preliminary report, we present arguments that F has a transversal in the case that $k=5$ and $d=4/3$ (Received January 31, 2012)

1080-52-342 **Dan P Ismailescu*** (dan.p.ismailescu@hofstra.edu), 103 Hofstra University, Hempstead, NY 11549. *A Surprising Geometric Transformation*. Preliminary report.

For any integer $n \geq 2$, a square can be partitioned into n^2 smaller squares via a *checkerboard-type* dissection. Does there such a “class preserving grid dissection” exist for some other types of quadrilaterals? For instance, is it true that a circumscribed quadrilateral (that is, a quadrilateral whose sides are tangent to a circle) can be partitioned into n^2 smaller circumscribed quadrilaterals, via such a “ $n \times n$ grid dissection”? We prove that the answer is affirmative for every integer $n \geq 2$. Joint work with Chung-Su Hong. (Received January 31, 2012)

1080-52-350 **Andras Bezdek*** (bezdean@auburn.edu), Department of Mathematics and Statistics, Auburn University, Auburn, AL 36849-5310. *On fair partitions of polygons*. Preliminary report.

A convex partition of a polygon P is a finite set of convex polygons such that the interiors of the polygons do not intersect and the union of the polygons is equal to the original polygon P . The desire to create optimal partitions of a given convex polygon furnished a number of problems in discrete geometry. The properties used in optimization among others include equal area, equal perimeter and the number of pieces. The concept of fair partitions commonly refers to problems where simultaneously several properties need to be optimized. Variations of the cake-cutting problem are the most known problems among these. This talk surveys some of the 2D and 3D results and introduces some new variants. We are particularly interested in optimization problems which are restricted to triangulations only. (Received January 31, 2012)

53 ► Differential geometry

1080-53-3 **Anna Wienhard*** (wienhard@math.princeton.edu), Washington Road, Fine Hall, Princeton, NJ 08544. *Deformation spaces of geometric structures*.

The moduli space of flat bundles is a central object in several mathematical fields. Closely related is the deformation space of locally homogeneous geometric structures. These spaces parametrize equivalence classes of representations of the fundamental group of a space Σ , or equivalently flat connections on bundles over Σ .

The study of deformation spaces of geometric structures has recently received revived attention. In this talk I will survey three recent developments and their interrelations: Geometric structures on 3-manifolds, Higher Teichmüller theory and Anosov representation. (Received January 30, 2012)

1080-53-48 **Chanyoung Jun*** (cyjun2@gmail.com), 1409 W. Green Street, Urbana, IL 61801. *Pursuit-evasion and time-dependent gradient flow in singular spaces*.

Pursuit-evasion games are generated from robotics, control theory and computer simulations. $CAT(0)$ and $CAT(K)$ spaces are suitable playing fields, and vastly generalize the usual playing fields in the pursuit-evasion literature. On these spaces, we prove existence and uniqueness theorems for pursuit curves, as well as convergence estimates and a regularity theorem. Recently, time-independent gradient flow has been studied extensively in $CAT(0)$ spaces. Pursuit curves are downward gradient curves for the distance from a moving evader, that is, for a time-dependent gradient flow. We extend our results to more general time-dependent gradient flow in $CAT(0)$ spaces. (Received December 20, 2011)

1080-53-61 **Biao Wang*** (biao.wang@ccsu.edu), Department of Mathematics, Central Connecticut State University, New Britain, CT 06050. *Quasi-Fuchsian 3-manifolds that contain arbitrarily many incompressible minimal surfaces.*

Let Γ be a Kleinian group, if its limit set Λ_Γ is a Jordan curve other than a circle, which is invariant under Γ , and if each component of the region of discontinuity of Γ is also invariant under Γ , then Γ is called a quasi-Fuchsian group. Topologically, the orbit space $M = \mathbb{H}^3/\Gamma$ is a complete hyperbolic 3-manifold, called a quasi-Fuchsian 3-manifold, which is diffeomorphic to $S \times \mathbb{R}$, here S is a finite type Riemann surface with negative Euler characteristic. In this notes, we assume that S is a closed surface with genus ≥ 2 .

Each quasi-Fuchsian 3-manifold M contains a (compact) convex core, therefore M always contains at least one incompressible minimal surface by the works of Meeks-Yau and Sacks-Uhlenbeck. On the other hand, M. Anderson also proved that M only contains finitely many incompressible minimal surfaces.

In this notes, we try to construct a family of quasi-Fuchsian 3-manifolds that contain at least 2^N incompressible minimal surfaces for any given positive integer N . We use the minimal (spherical) catenoids in \mathbb{H}^3 as the barrier surfaces to get distinct minimal surfaces. (Received December 29, 2011)

1080-53-69 **Peter Connor*** (pconnor@iusb.edu) and **Kevin Li**. *Gluing constructions of embedded doubly periodic minimal surfaces.*

In this talk, we will explain how two of the oldest known minimal surfaces, the singly and doubly periodic Scherk surfaces, can be glued together in various ways to construct new examples of embedded minimal surfaces. Background and motivation are included. (Received January 06, 2012)

1080-53-137 **L. Xiao*** (lxiao8@jhu.edu), Johns Hopkins University, Department of Mathematics, 404 Krieger Hall, Baltimore, MD 21210. *Curvature Flow Of Complete Convex Hypersurfaces In Hyperbolic Space.*

We investigate the existence, convergence and uniqueness of modified general curvature flow (MGCF) of convex hypersurfaces in hyperbolic space with a prescribed asymptotic boundary. (Received January 21, 2012)

1080-53-165 **Longzhi Lin*** (lzlin@math.rutgers.edu), Department of Mathematics, Rutgers University, 110 Frelinghuysen Road, Piscataway, NJ 08854-8019, and **Tobias Lamm**. *Estimates on the energy density for critical points of a class of conformally invariant variational problems.*

We will discuss a global estimate (in the local Hardy space) on the energy density of critical points of a class of conformally invariant variational problems with small energy on the unit 2-disc, using Riviere's gauge decomposition technique and Wentze's inequality. As a corollary we obtain a new proof of the energy convexity and uniqueness result for weakly harmonic maps with small energy on the unit 2-disc. This is a recent joint work with Tobias Lamm. (Received January 24, 2012)

1080-53-174 **Casey Douglas*** (cjdouglas@smcm.edu), St. Mary's College of Maryland, St. Mary's City, MD 20686. *Weighted Geodesics and Self-similar Curve Shortening.*

We will review some recent and more elementary proofs of classic results obtained by Abresch & Langer concerning the existence and classification of homothetic solutions to the (normalized) curve shortening flow. Open questions and new directions will be discussed. (Received January 25, 2012)

1080-53-207 **Mihai Bailesteanu*** (bailesteanu@math.rochester.edu), University of Rochester, Department of Mathematics, 801 Hylan Building, ROCHESTER, NY 14607. *Type III Ricci flow - investigations.* Preliminary report.

We study the behavior of Type III Ricci flow. All known compact 3-dimensional solutions of the Ricci flow, for time $t \in (0, \infty)$ are type III. In particular we try to obtain heat kernel estimates and convergence results. (Received January 27, 2012)

1080-53-233 **Subhojoy Gupta*** (subhojoy.gupta@yale.edu), 10 Hillhouse Avenue, New Haven, CT 06511. *Asymptoticity of grafting and Teichmüller rays.*

We shall discuss a result showing that any grafting ray in Teichmüller space determined by an arational lamination or a multi-curve is (strongly) asymptotic to a Teichmüller geodesic ray. Our method involves constructing quasiconformal maps between the underlying Thurston metric of a complex projective surface on one hand, and the singular flat metric induced by a holomorphic quadratic differential on the other. I shall focus on the analytic aspects of this construction. (Received January 28, 2012)

1080-53-262 **R. Laverdiere*** (renee.laverdiere@rice.edu). *Evolution of geometric invariants along grafting rays.*

Grafting rays provide polar coordinates for Teichmüller space, and much is known about their asymptotic behavior. In this talk we instead focus on understanding the mid-range of a grafting ray. In particular, we will consider an explicit formula describing the behavior of some geometric invariants along grafting rays and discuss some implications. (Received January 29, 2012)

1080-53-263 **Yuan Yuan***, 3400 N. Charles Street, Baltimore, MD. *Metric flips by the Kähler-Ricci flow.* Preliminary report.

I will talk about the limiting behavior of the Kähler–Ricci flow on a class of projective manifolds. The flow either shrinks to a point, collapses to the base projective space or contracts a subvariety of codimension greater than one in the Gromov–Hausdorff sense. (Received January 29, 2012)

1080-53-264 **Lu Wang*** (lwang@math.jhu.edu), 3400 N Charles Street, Baltimore, MD 21218. *Uniqueness of Self-similar Shrinkers under Mean Curvature Flow.*

In this talk, we will discuss the uniqueness of self-shrinkers under the mean curvature flow assuming their asymptotics, including a partial answer to Ilmanen’s cylinder rigidity conjecture. (Received January 29, 2012)

54 ► General topology

1080-54-144 **Peter Lee*** (peterdovjak@yahoo.ca), 17 Bowman Street, Toronto, Ontario M4X 1V1, Canada. *The Pure Virtual Braid Group is Quadratic.*

If an augmented algebra K over \mathbb{Q} is filtered by powers of its augmentation ideal, the associated graded algebra $\text{gr}K$ need not in general be quadratic: although it is generated in degree 1, its relations may not be generated by homogeneous relations of degree 2. In this talk we give a sufficient criterion (called the PVH Criterion) for $\text{gr}K$ to be quadratic. When K is the group algebra of a group G , quadraticity is known to be equivalent to the existence of a (not necessarily homomorphic) universal finite type invariant for G . Thus the PVH Criterion also implies the existence of a universal finite type invariant for the group G . We will outline the application of the PVH Criterion to the group algebra of the pure virtual braid group (also known as the quasi-triangular group), which shows that the corresponding associated graded algebra is quadratic, and hence that these groups have a universal finite type invariant. (Received January 22, 2012)

57 ► Manifolds and cell complexes

1080-57-41 **Reza Chamanara, Jun Hu and Joel Zablow*** (dquandle@netscape.net). *Extending the Dehn quandle to shears and foliations on the torus.*

Working on the torus \mathbb{T}^2 , we extend the original Dehn quandle action given by Dehn twists along circles, applied to circles, to a quandle structure for shears along measured geodesic foliations acting upon such foliations. This generalizes the Dehn quandle of the torus. We extend results relating the homology of the Dehn quandle of a surface to invariants of Lefschetz fibrations over the disk D^2 , having the given surface as fiber. The original invariants dealt with monodromy associated to reducible homeomorphisms. The extension, in the case of a fibration by tori, considers monodromy associated to Anosov homeomorphisms of the torus. We also apply certain quandle homology 2-cycles to obtain specific factorizations of certain elements of $\text{SL}(2, \mathbb{R})$, fixing vectors corresponding to circles and measured geodesic foliations. (Received December 12, 2011)

1080-57-110 **Alissa S. Crans*** (acrans@lmu.edu), **Sam Nelson** and **Louis H. Kauffman**. *Hom Quandles.* Preliminary report.

Analogous to the case for groups, the collection of quandle homomorphisms, $\text{Hom}(Q, X)$, has no natural quandle structure. However, if X is an *abelian* quandle, then the hom set does become a quandle with the obvious pointwise operation. We will consider examples and investigate properties of this hom quandle. This is a preliminary report on work in progress with Sam Nelson and Lou Kauffman. (Received January 17, 2012)

1080-57-120 **Heather A Dye*** (hadye@mckendree.edu), **Louis Kauffman** and **Aaron Kaestner**. *Khovanov homology for virtual knots.* Preliminary report.

We define a Khovanov homology for virtual knots with integer coefficients. Virtual crossings introduce the possibility of a 1-1 bifurcation: changing the smoothing type of crossing in a virtual knot or link does not always

change the number of components in the smoothed states. As a result, we need to redefine the boundary maps in the homology theory and prove that invariance still holds. (Received January 19, 2012)

1080-57-150 **Louis H Kauffman*** (kauffman@uic.edu), Math UIC, 851 South Morgan Street, Chicago, IL 60607-7045. *Non-Commutativity and Discrete Physics*. Preliminary report.

This talk will discuss a framework for discrete physics where all derivatives are replaced by commutators. (Received January 22, 2012)

1080-57-152 **Louis H Kauffman*** (kauffman@uic.edu), Math UIC, 851 South Morgan Street, Chicago, IL 60607-7045. *Khovanov Homology and Quantum Computation*.

This talk will discuss how, over the complex numbers, the vector space for Khovanov Homology can be seen as a natural Hilbert space for quantum algorithms computing the Jones polynomial and we raise the question of finding quantum algorithms for computing Khovanov Homology itself. (Received January 22, 2012)

1080-57-208 **Joan E. Licata*** (jelicata@ias.edu) and **Joshua M. Sabloff**. *Combinatorial Legendrian Contact Homology in Contact Seifert Fibered Spaces*.

Legendrian knot theory in manifolds beyond \mathbb{R}^3 has seen increased attention in recent years. In this talk, I'll consider Seifert fibered spaces equipped with a transverse, S^1 -invariant contact structure. To a Legendrian knot in such a manifold, we associate a differential graded algebra. This construction is a combinatorial model of Legendrian contact homology, and the invariant identifies an infinite family of non-simple knot types representing torsion homology classes. (Received January 27, 2012)

1080-57-223 **Benjamin Cooper** and **Slava Krushkal*** (krushkal@virginia.edu). *Picture TQFTs, categorification, and localization*.

A “geometric” construction of $SU(2)$ (2+1)-dimensional TQFTs associates to a surface the vector space spanned by multi-curves modulo local relations. The relevant local relations are defined by the Jones-Wenzl projectors. This talk will outline an approach to categorification of this picture construction of TQFTs, and it will explain how the evaluation at a root of unity may be viewed as a localization of a category. (Received January 27, 2012)

1080-57-243 **Masahico Saito*** (saito@usf.edu), **W. Edwin Clark**, **Mohamed Elhamdadi**, **Xiang-dong Hou** and **Timothy Yeatman**. *Connected quandles associated with pointed abelian groups*.

For each abelian group A and $c \in A$, we define a quandle $G(A, c)$ on $\mathbb{Z}_3 \times A$. We classify their isomorphism classes in terms of pointed abelian groups, and study their various properties, such as being Latin, Alexander, and faithful. A family of symmetric connected quandles is constructed from these quandles, and some aspects of knot colorings are also discussed. (Received January 28, 2012)

1080-57-254 **Denis Auroux**, **J. Elisenda Grigsby** and **Stephan M. Wehrli*** (smwehrli@syr.edu). *Diagram algebras in Khovanov- and Heegaard Floer-type homology theories*. Preliminary report.

Given a tangle, one can associate to it two different sequences of categorified tangle invariants: the Khovanov homology bimodules defined by Chen-Khovanov and Brundan-Stroppel, and the bordered Floer homology bimodules of the branched double-cover of the tangle, defined by Lipshitz-Ozsváth-Thurston. In this talk, I will discuss a partial relationship between these two sequences of invariants and, in particular, describe a connection between the generators of the dg-algebras appearing in the two theories. (Received January 29, 2012)

1080-57-260 **Michael Fitzpatrick**, **Charles D Frohman** and **Joanna Kania-Bartoszyńska*** (jkaniaba@nsf.gov), Division of Mathematical Sciences, National Science Foundation, Arlington, VA 22230. *Quantum representations of the mapping class group*. Preliminary report.

We describe the Topological Quantum Field Theory underlying the Kauffman bracket invariant of links. We discuss how to obtain quantum projective representations of a mapping class group of a surface from that theory. We show that for a once punctured torus the projective quantum representations, which are defined at roots of unity, can be extended continuously to the whole unit circle. (Received January 29, 2012)

1080-57-265 **Xuanting Cai** and **Patrick M Gilmer*** (gilmer@math.lsu.edu), Department of Mathematics, Louisiana State University, Baton Rouge, LA 70704. *The Turaev-Viro Endomorphism and the Jones Polynomial*. Preliminary report.

By applying a variant of the TQFT in [BHMV], and using a construction of Ohtsuki, we define an endomorphism for each knot K by using a tangle obtained from a surgery presentation of K . We show that this endomorphism is strong shift equivalent to the Turaev-Viro endomorphism. Following Viro, we consider the endomorphism that one obtains after first coloring the meridian and longitude of the knot. We show that the traces of these endomorphisms encode the same information as the colored Jones polynomials at a root of unity. (Received January 29, 2012)

1080-57-269 **Moshe Cohen** and **Adam Lowrance*** (adam-lowrance@uiowa.edu), Department of Mathematics, 14 MacLean Hall, University of Iowa, Iowa City, IA 52242. *A categorification of the Tutte polynomial*. Preliminary report.

We construct a categorification of the Tutte polynomial for graphs and matroids. Our categorification is a triply-graded vector space whose graded Euler characteristic is the Tutte polynomial. We discuss generalizations of the deletion-contraction and duality formulas for the Tutte polynomial. We also show how to obtain an invariant of alternating knots and discuss a possible relationship with Khovanov homology. (Received January 30, 2012)

1080-57-272 **Jozef H. Przytycki*** (przytyck@gwu.edu), Department of Mathematics, George Washington University, Washington, DC 20052. *Kauffman bracket skein module of a thickened surface and virtual knots*. Preliminary report.

We discuss a following question: given a 3-dimensional manifold M , an incompressible surface $F \subset M$, and a link $L \subset M$ find conditions for which the following holds: $i(L, F) = \max(i(L_0, F), i(L_\infty, F))$, where L, L_0, L_∞ is a Kauffman bracket skein triple of links in M and $i(L, F)$ is a geometric intersection number. The question has its origin in an old (1987) Hoste-Przytycki conjecture that if L is a link in a solid torus and its expression in the Kauffman bracket skein module is $L \equiv a_0 + a_1 h + \dots + a_k h^k$ ($a_k \neq 0$), then the wrapping number of L is equal to k . Partial answer to the question was suggested by Traczyk and proven by Bullock. The new interest in the problem was raised by Kauffman question of effective way of finding minimal genus of a virtual knot. In this setting we think that our question has affirmative answer that is: Conjecture: If $M = F_g \times [0, 1]$ is a thickened closed surface of genus g and $L \subset M$ is a link then for any s.c.c. $\gamma \subset F$ we have $i(L, \gamma \times [0, 1]) = \max(i(L_0, \gamma \times [0, 1]), i(L_\infty, \gamma \times [0, 1]))$.

We ask analogous questions for Homflypt and Kauffman polynomials. (Received January 30, 2012)

1080-57-302 **Uwe Kaiser*** (kaiser@math.boisestate.edu), Department of Mathematics, Boise State University, Boise, ID 83725-1555. *On minimal generating sets of skein modules*. Preliminary report.

We discuss the problem of constructing a generating set of links, which spans a Homflypt skein module of an orientable 3-manifold. This problem has been solved for cylinders over surfaces by Przytycki but not much is known for general 3-manifolds. Using Heegard decomposition it becomes a difficult combinatorial problem. We develop some ideas how the extension of the problem to the relative case together with gluing properties of skein modules could be helpful. (Received January 30, 2012)

1080-57-329 **Jim Hoste*** (jhoste@pitzer.edu) and **Patrick D Shanahan** (pschanahan@lmu.edu). *Twisted Alexander polynomials of 2-bridge knots*. Preliminary report.

We develop a method to compute the twisted Alexander polynomial associated to dihedral representations of 2-bridge knots. For several infinite classes of 2-bridge knots we use this method to verify a conjecture of Hirisawa and Murasugi on the form of the resulting polynomial. (Received January 31, 2012)

1080-57-370 **Oleg Viro*** (oleg@math.sunysb.edu), NY. *Duality aspects of Khovanov homology*. Preliminary report.

Various problems related to dualities in Khovanov homology, isotopies of knots and harmonic cycles will be discussed. (Received January 31, 2012)

1080-57-377 **Oliver T Dasbach*** (kasten@math.lsu.edu), Department of Mathematics, Lockett Hall 306, Baton Rouge, LA 70803, and **Cody Armond**. *On certain coefficients of the colored Jones polynomial*. Preliminary report.

We discuss the leading coefficients of the colored Jones polynomials of certain classes of links. (Received January 31, 2012)

58 ► *Global analysis, analysis on manifolds*

1080-58-122 **Gerard Misiolek***, School of Mathematics, the Institute for Advanced Study, Princeton, NJ 08540. *The Fisher-Rao metric on the diffeomorphism group.*

I will show how this metric arises on diffeomorphism groups, describe its geometry and the associated Euler-Arnold equation. (Received January 19, 2012)

60 ► *Probability theory and stochastic processes*

1080-60-6 **Tim S.T. Leung*** (t12497@columbia.edu), Rm. 308A, S. W. Mudd Building, 500 West 120th Street MC4704, New York, NY 10027. *Stochastic Modeling for Executive Compensation.*

We will discuss the characteristics of several instruments for executive compensation, including employee stock options (ESOs) and restricted stocks. Due to trading restrictions and contractual features, there are major challenges in optimally managing these options/stocks, as well as in estimating their costs. This gives rise to the need of robust mathematical valuation models. (Received September 13, 2011)

1080-60-70 **Maxim Bichuch*** (mbichuch@princeton.edu), DEPT OF OPERATIONS RESEARCH & FINANCIAL ENG, Princeton University, 98 CHARLTON ST, Princeton, NJ 08540. *Pricing a Contingent Claim Liability Using Asymptotic Analysis for Optimal Investment in Finite Time with Transaction Costs.*

We price a contingent claim liability using the utility indifference argument. We consider an agent with exponential utility, who invests in a stock and a money market account with the goal of maximizing the utility of his investment at the final time T in the presence of positive proportional transaction cost in two cases with and without a contingent claim liability. Using the computations from the heuristic argument in Whalley & Wilmott we provide a rigorous derivation of the asymptotic expansion of the value function in the transaction cost parameter around the known value function for the case of zero transaction cost in both cases with and without a contingent claim liability. Additionally, using utility indifference method we derive an asymptotic expansion of the price of the contingent claim liability. In both cases, we also obtain a “nearly optimal” strategy, whose utility asymptotically matches the leading terms of the value function. (Received January 06, 2012)

1080-60-167 **Gourab Ghoshal*** (gourab.ghoshal@gmail.com) and **Albert-Laszlo Barabasi**. *Ranking stability and super-stable nodes in complex networks.*

Pagerank, a network-based diffusion algorithm, has emerged as the leading method to rank web content, ecological species and even scientists. Despite its wide use, it remains unknown how the structure of the network on which it operates affects its performance. Here we show that for random networks the ranking provided by pagerank is sensitive to perturbations in the network topology, making it unreliable for incomplete or noisy systems. In contrast, in scale-free networks we predict analytically the emergence of super-stable nodes whose ranking is exceptionally stable to perturbations. We calculate the dependence of the number of super-stable nodes on network characteristics and demonstrate their presence in real networks, in agreement with the analytical predictions. These results not only deepen our understanding of the interplay between network topology and dynamical processes but also have implications in all areas where ranking has a role, from science to marketing. (Received January 24, 2012)

1080-60-331 **Jin Wang*** (jin.d.wang@gmail.com), Department of Chemistry and Physics, Stony Brook University, Stony Brook, NY 11794-3400. *Potential and Flux Landscape Theory of Networks.*

We developed a general framework to quantify three key ingredients for dynamics of nonequilibrium systems. First, we identify dominant kinetic paths as the ones with optimal weights, leading to effective reduction of dimensionality or degrees of freedom from exponential to polynomial so large systems can be treated. Second, we uncover the underlying nonequilibrium potential landscapes from the explorations of the state space through kinetic paths. We apply our framework to a specific example of nonequilibrium network system: lambda phage genetic switch. Two distinct basins of attractions emerge. The dominant kinetic paths from one basin to another are irreversible and do not follow the usual gradient path along the landscape. It reflects the fact that the dynamics of nonequilibrium systems is not just determined by potential gradient but also the curl flux force. Third, we have calculated dynamic transition time scales from one basin to another critical for stability of the system and uncover its correlations to the underlying landscape topography: the barrier heights along

the dominant paths. Our theoretical framework is general and can be applied to other nonequilibrium systems. (Received January 31, 2012)

62 ► *Statistics*

1080-62-234 **Rebecca F. Goldin*** (rgoldin@math.gmu.edu), MS 3F2, 4400 University Drive, Fairfax, VA 22039, and **Giorgio A. Ascoli, David Marchette** and **Carey Priebe**. *A Random Graph Model for Neuronal Connectivity*.

The mammalian brain is a large network of neurons (approximately 10^8 in rodents, up to 10^{11} in humans), sparsely interconnected by synapses (approx. 10^4 per neuron). The common working assumption posits the existence of distinct “neuronal classes,” where neurons in the same class share similar connectivity patterns compared to neurons in different classes. We introduce a probabilistic model that formalizes the concept of neuronal class based on network connectivity. Given a complete list of all neurons and their connections in a network, we present a technique to estimate the number of neuronal classes, and an assignment of each neuron to a class. We model the connectome using a random dot product model, in which the connection probability is determined by the dot product of latent vectors associated with the pre- and post-synaptic neurons. We fit the model using sparse singular value decomposition, and cluster the latent vectors into groups, which define the proposed neuronal classes. Using neurobiologically realistic surrogate data, we demonstrate that this approach is robust and computationally tractable. This model provides both a practical and theoretical foundation to bridge neuronal- and system-level neuroanatomy. (Received January 28, 2012)

1080-62-336 **Kevin McGoff***, Mathematics Department, Duke University, Box 90320, Durham, NC 27708-0320. *Statistical parameter inference in dynamical systems*. Preliminary report.

A common setting across many areas of science and engineering is that one would like to model time series data using some dynamical models. Often a model can be constructed, but the parameters of the model must be chosen according to how well they fit the data. In this talk we survey some of the main approaches to statistical parameter estimation for both deterministic and stochastic models of the dynamics, along with various types of noise. We also discuss some recent joint work with John Harer, Sayan Mukherjee, and Natesh Pillai on designing a database approach to parameter estimation using ideas from Conley Index theory. (Received January 31, 2012)

65 ► *Numerical analysis*

1080-65-20 **WASEEM ASGHAR KHAN*** (waseem_asg@yahoo.com), DEP. OF MATHEMATIC CIIT, ISLAMABAD, PAKISTAN, ISLAMABAD, Pakistan. *He's frequency formulation for higher-order nonlinear oscillators and nonlinear oscillator with discontinuous*.

Based on an ancient Chinese algorithm, J H He suggested a simple but effective method to find the frequency of a higher-order nonlinear oscillator and nonlinear oscillator with discontinuous. In this paper, we use this method on higher-order nonlinear oscillators and nonlinear oscillator with discontinuous to improve the accuracy of the frequency; these two higher-order examples are given, revealing that the obtained solutions are of remarkable accuracy and are valid for the whole solution domain (Received October 31, 2011)

1080-65-337 **Shishen Xie*** (xies@uhd.edu), Department of Computer and Math Sciences, University of Houston-Downtown, Houston, TX 77002. *Numerical algorithms to solve an integro-differential equation arising from viscoelasticity*. Preliminary report.

Numerical algorithms are developed to solve partial integro-differential equations arising from viscoelasticity. Numerical solutions based on the algorithms are obtained for both non-Newtonian and Newtonian fluids. The numerical results are also compared with standard finite difference methods. The advantages of the algorithm become obvious because of its ability to solve the integro-differential equations rapidly with excellent accuracy. (Received January 31, 2012)

1080-65-345 **Cindy R. Christensen*** (christcr@nv.doe.gov), 182 East Gate Drive, Los Alamos, NM 87544. *A Non-invasive Energy / Angle Diagnostic for Charged Particle Beams*.

There is a great need for non-invasive diagnostics for charged particle beams such as particle accelerators and high-current discharge experiments. Compton scattering of a pulsed laser beam by a high-current electron beam can be used to diagnose the energy and angular distributions of the electrons. Unfolding of the signals from

multiple optical detectors (IR, visible, UV, and X-ray) can enable reconstruction of energy and angle profiles. The relativistic calculations present great challenges. DOE/NV/25946-1420 (Received January 31, 2012)

68 ► *Computer science*

1080-68-40 **Hanna Makaruk*** (hann_m@lanl.gov), MS D410, P-21, Los Alamos National Laboratory, Los Alamos, NM 87545. *Generalization of Inverse Abel Transform 3D objects reconstruction from single radiographs for selected cases not fulfilling the axial symmetry assumption*. Preliminary report.

Inverse Abel Transform is a standard way of reconstructing a 3D axially symmetric object from a single radiographic image. Experimental radiographic data rarely fulfill strict mathematical requirement about the symmetry. Therefore we need to quantify the error generated when the symmetry assumption is not strictly satisfied. In fact we may try to achieve even more: to generalize the Abel Inversion procedure in order to recreate the objects also in cases with known or expected perturbation of the symmetry. The errors in classical Inverse Abel Transform applied to reconstruction of objects with the axial symmetry perturbed include volumes of reconstructed negative density of macroscopic size, with the negative values comparable to or even bigger than the original object's density. Explanation of these surprising reconstructions was the starting point of our investigation. Analytical results and their comparison with some experimental examples and/or synthetic radiograms will be presented. (Received December 12, 2011)

1080-68-158 **Sebastian Wyman*** (swyman@uf1.edu) and **Douglas Cenzer**. *Weakening computability to classify Π_1^0 subshifts*.

In 2008 Cenzer, Dashti, and King proved that the subshifts arising from the symbolic dynamics of computable functions on the Cantor space are exactly the decidable Π_1^0 classes. We will show a useful lemma which can be extracted from the CDK proof. We then define the weaker notion of conservatively computable functions on the cantor space and explore the correspondence between these functions and arbitrary Π_1^0 classes. (Received January 23, 2012)

1080-68-277 **Simina Branzei*** (simina@cs.au.dk), IT-parken, Aabogade 34, 8200 Aarhus, Denmark. *On equilibria of moving-knife algorithms for cake-cutting*. Preliminary report.

Moving knife procedures have been studied intensely in fair division. We consider the competitive version of moving-knife algorithms, discuss the existence of equilibria and several computational results when the representation of the valuation functions is succinct. (Received January 30, 2012)

74 ► *Mechanics of deformable solids*

1080-74-27 **Abdalla A Obeidat*** (aobeidat@just.edu.jo), Physics department, Irbid, Irbid 22110, Jordan, and **Akram A Rousan** and **Khitam Khasawinah**. *Applications of Fractional Calculus to Gravity*.

Fractional calculus is used to study gravitational fields. It is shown that a point mass distribution and its potential are the differentials (differintegration of order 1) of the uniform semi-infinite linear mass distribution and its potential, respectively. The intermediate stages between the two cases are studied by varying the order of the differintegration from 0 to 1. (Received November 24, 2011)

76 ► *Fluid mechanics*

1080-76-127 **Mulugeta Markos*** (mmarkos@ncwc.edu), 2322 Dove Court, Rockt Mount, NC 27804. *The role of the adiabatic region in a steady liquid flow in designing micro heat pipes*.

In this paper we examined the shape of the interface when thermocapillary effect is insignificant and then consider the effect of thermocapilarity T he paper presents a lubrication-type model of liquid flow and heat transfer in different groove structures in micro heat pipes under negligible gravity and small capillary number. The flow rate could be controlled by changing the shape of the cross-section in the adiabatic region. The optimum flow rate is determined as a function of the given geometry. Determination of the vapor-liquid interface shape in the grooves requires coupling of fluid flow and heat transfer. (Received January 20, 2012)

78 ► *Optics, electromagnetic theory*

1080-78-212 **Gerald A. Goldin*** (geraldgoldin@dimacs.rutgers.edu), Rutgers University, SERC Building, Rm. 239, Busch Campus, 118 Frelinghuysen Road, Piscataway, NJ 08854. *Nonlinear conformal electrodynamics*. Preliminary report.

One way to generalize classical electrodynamics is to introduce nonlinear constitutive equations consistent with the Lorentz symmetry. While the usual, linear Maxwell equations are incompatible with a Galilean limit obtained by taking the light speed to infinity, there are interesting nonlinear variations that allow this limit. The method generalizes to Yang-Mills equations and to supersymmetric theories (and may even have application to the theory of tensionless strings). After developing this idea, I shall describe some current explorations of nonlinear electromagnetism respecting conformal symmetry. The conformal compactification of Minkowski space has the topology of $S^1 \times S^3/Z_2$, which maps to the projective light cone in $(4+2)$ -dimensional space-time. Here the generators of the conformal group act as rotations. Work going back to Dirac makes use of this idea to discuss linear electrodynamics. But one can write nonlinear constitutive equations that depend on rotation-invariant functionals of the field strength tensor, generalizing the approach to a description of nonlinear conformal electrodynamics. This talk is based on joint work with Vladimir Shtelen and Steven Duplij. (Received January 27, 2012)

80 ► *Classical thermodynamics, heat transfer*

1080-80-55 **SUSHIL KUMAR*** (sushilk@ashd.svnit.ac.in), Applied Mathematics & Humanities Department, S V National Institute of Technology, Surat, Gujarat 395007, India. *Study on moving boundary problem during convective freezing with energy generation*. Preliminary report.

In the present study, a moving boundary problem during convective freezing in a cylindrical domain with volumetric heat generation is carried out. Enthalpy formulation of freezing process is solved using finite difference method. It is found that an increase in heat generation slows down the freezing process for the given convective cooling. (Received December 26, 2011)

81 ► *Quantum theory*

1080-81-56 **Dionisios Margetis*** (dio@math.umd.edu), 2110 Mathematics Bldg., Department of Mathematics, University of Maryland, College Park, MD 20742. *Bose-Einstein condensation beyond mean field: Many-body bound state of periodic microstructure*.

We formally discuss time-independent quantum fluctuations of a mean field limit in trapped, dilute atomic gases of repulsively interacting Bosons at zero temperature. In the mean field limit, the wave function, $\Phi(t, x)$, of the condensate satisfies a defocusing cubic nonlinear Schrödinger-type equation (NSE), the Gross-Pitaevskii equation. We include macroscopic consequences of pair excitation, i.e., the scattering of particles in pairs from the condensate to other states. On the basis of an uncontrolled ansatz for the many-body wave function and a microscopic Hamiltonian with spatially varying interaction strength, we derive a Φ -dependent integro-partial differential equation for the pair collision kernel, K . For a scattering length with periodic microstructure of subscale ϵ , we describe the effective many-body lowest bound state in terms of Φ and K up to second order in ϵ . (Received December 26, 2011)

1080-81-257 **Razvan Gelca*** (rgelca@gmail.com), Department of Mathematics and Statistics, Texas Tech University, Lubbock, TX 79410. *Classical theta functions in a quantum group perspective*. Preliminary report.

In this talk we describe the quantum group that models the theory of classical theta functions. The context is that of abelian Chern-Simons theory in the Reshetikhin-Turaev perspective. (Received January 29, 2012)

1080-81-335 **Mikhail Khovanov*** (khovanov@math.columbia.edu). *Diagrammatical algebra*. Preliminary report.

We'll review an approach to certain monoidal categories and 2-categories via planar generators and relations. Examples include categorifications of quantum groups, Hecke and Heisenberg algebras. (Received January 31, 2012)

82 ► *Statistical mechanics, structure of matter*

1080-82-230 **Robert M Owczarek*** (owczarek@hughes.net), 59 Coryphodon Ln, Jemez Springs, NM 87025. *Statistical physics and fluid mechanics*. Preliminary report.

Statistical physics methods applied in (quantum) fluid mechanics will be discussed. (Received January 28, 2012)

83 ► *Relativity and gravitational theory*

1080-83-24 **Vladimir Chernov*** (vladimir.chernov@dartmouth.edu) and **Stefan Nemirovski** (stefan@mi.ras.ru). *Computing causal relation between events from the set of points where the events are visible at a given time moment*.

Two points in a spacetime are said to be causally related if information traveling with less or equal than light speed can get from one point to the other. We show that for a large class of spacetimes two points are causally related if and only if the spheres of all light rays through these points are Legendrian linked in the space of all light rays.

This can be interpreted as the statement that one can tell if two events are causally related or not from the set of points in the universe where the events are visible at any given moment of time (level set of a timelike function). In particular this gives solutions to the Low conjecture and to the Legendrian Low conjecture formulated by Natario and Tod. (Received January 30, 2012)

90 ► *Operations research, mathematical programming*

1080-90-10 **Vikram Jeet Singh*** (vikram31782@gmail.com), H.no 908/7 Street no.4, Kot Atma Singh, Ram Bagh, Amritsar, Punjab 143001, India. *AN EPQ Model for Deterioration Items and Exponential Demand Rate Taking into Account the Time Value of Money*. Preliminary report.

In this study we develop an inventory model with exponential demand with Time Value of Money. Deterioration occurs as soon as the items are received into inventory and it follows two parameter Weibull distributions. There is no repair or replacement of deteriorating items during the replenishment cycle. Product transactions are followed by instantaneous cash flow. Shortages are allowed and partially backlogged. The system operates for a prescribed period of a planning horizon. Production rate is demand rate dependent. The problem is discussed under the inflationary environment (Received September 23, 2011)

1080-90-26 **Stephen G Nash*** (snash@gmu.edu), Systems Eng. & Operations Research Dept., George Mason University, MS 4A6, Fairfax, VA 22030. *Multilevel Optimization Methods for Engineering Design and PDE-Constrained Optimization*.

Many large nonlinear optimization problems are based upon a hierarchy of models, corresponding to levels of discretization or detail in the problem. This is true for many engineering design problems, as well as for optimization problems that include partial differential equations as constraints. Optimization-based multilevel methods - that is, multilevel methods based on solving coarser approximations of an optimization problem - are designed to solve such multilevel problems efficiently by taking explicit advantage of the hierarchy of models. The methods are generalizations of more traditional multigrid methods for solving partial differential equations. However, the optimization approach admits a richer class of models and has better guarantees of convergence. The optimization-based multilevel methods also generalize model-management approaches for solving engineering design problems. These multilevel methods are a powerful tool, and can dramatically out-perform traditional optimization algorithms. (Received November 23, 2011)

1080-90-52 **M. Seetharama Gowda*** (gowda@math.umbc.edu), Department of Mathematics and Statistics, UMBC, Baltimore, MD 21250. *Lyapunov-like transformations on proper cones*.

\mathbf{Z} and Lyapunov-like transformations on cones are, respectively, generalizations of \mathbf{Z} -matrices and diagonal matrices. Such transformations appear in optimization and dynamical systems. Given a proper cone K in a real finite dimensional Hilbert space H , a linear transformation L on H is said to be Lyapunov-like on K if

$$x \in K, y \in K^*, \text{ and } \langle x, y \rangle = 0 \Rightarrow \langle L(x), y \rangle = 0,$$

where K^* denotes the dual of K . For any real square matrix A , the Lyapunov transformation $L_A(X) = AX + XA^T$ on the semidefinite cone is an example of a Lyapunov-like transformation.

In this introductory/survey talk, we show how to characterize such transformations on polyhedral cones, symmetric cones, completely positive cones, etc. These results are achieved by relating Lyapunov-like transformations to automorphisms of the underlying cone and the elements of the Lie algebra of the automorphism group of the cone. By relating Lyapunov-like transformations to bilinearity relations of a cone, we show how to compute the bilinearity rank of a proper cone in some specific cases.

Finally, we describe the **P** and **GUS** (complementarity) properties of Lyapunov-like transformations on symmetric cones.

(Received December 23, 2011)

1080-90-63 **Jiyuan Tao*** (jtao@loyola.edu), Loyola University Maryland, Baltimore, MD 21210.
Linear Complementarity Problem with Pseudomonotonicity on Euclidean Jordan Algebras.

In this talk, we present interconnections between pseudomonotonicity, the P_0 -property, the column sufficiency property, the **P**-property, and the **GUS**-property in the setting of Euclidean Jordan algebras. (Received January 02, 2012)

1080-90-101 **M. Seetharama Gowda** (gowda@math.umbc.edu), University of Maryland, Baltimore County, Baltimore, MD 21250, **Jiyuan Tao** (jtao@loyola.edu), Loyola University Maryland, Baltimore, MD 21210, and **Roman Sznajder*** (rsznajder@bowiestate.edu), Department of Mathematics, Bowie State University, Bowie, MD 20715. *Complementarity properties of Peirce-diagonalizable linear transformations on Euclidean Jordan Algebras.*

Peirce-diagonalizable linear transformations on a Euclidean Jordan algebra are of the form $L(x) = A \bullet x := \sum a_{ij}x_{ij}$, where $A = [a_{ij}]$ is a real symmetric matrix and $\sum x_{ij}$ is the Peirce decomposition of an element x in the algebra with respect to a Jordan frame. Examples of such transformations include Lyapunov transformations and quadratic representations on Euclidean Jordan algebras. Schur (or Hadamard) product of symmetric matrices provides another example. Motivated by a recent generalization of the Schur product theorem, in this article, we study general and complementarity properties of such transformations. (Received January 15, 2012)

1080-90-105 **Farid Alizadeh*** (alizadeh@rutcor.rutgers.edu), RUTCOR, 640 Bartholomew Rd, Piscataway, NJ 08854, and **David Papp** (dpapp@iems.northwestern.edu), Evanston, IL. *An Algebraic view of sum-of-squares and their semidefinite representability, with applications.*

We extend Nesterov's semidefinite programming characterization of squared functional systems to cones of sum-of-squares elements in general abstract algebras. Using algebraic techniques such as isomorphism, linear isomorphism, tensor products, sums and direct sums, we show that many concrete cones are in fact sum-of-squares cones with respect to some algebra, and thus representable by the cone of positive semidefinite matrices. We also consider nonnegativity with respect to a proper cone \mathcal{K} , and show that in some cases \mathcal{K} -nonnegative cones are either sum-of-squares, or are semidefinite representable. For example we show that some well-known Chebychev systems, when extended to Euclidean Jordan algebras, induce cones that are either Sum-of-Squares cones or are semidefinite representable. Finally we will discuss some concrete examples and applications, including minimum ellipsoid enclosing given space curves, minimization of eigenvalues of polynomial matrix pencils, approximation of functions by shape-constrained functions, and approximation of combinatorial optimization problems by polynomial programming (Received January 16, 2012)

1080-90-143 **Osman Guler*** (guler@umbc.edu). *Second-order Conditions in Constrained Optimization.* We give a state-of-the-art view of second-order conditions in smooth constrained optimization. Although the conditions we discuss generally hold in infinite dimensional problems, including for optimal control problems, we restrict our talk to the finite-dimensional case. The second-order conditions come in two flavors - necessary and sufficient. Unlike the corresponding situation in unconstrained case, the conditions in constrained optimization tend to be intricate, and moreover, there is usually a gap between the assumptions made to prove theorems about the two flavors of the conditions. Starting in 1960s, there has been a steady flow of improvements in quality of theorems that can be proved, especially in necessary conditions, with the most recent results achieving a kind of parity in the assumptions they make. These new results use sophisticated limit ideas and penalty schemes. Many of these results have not made it into textbooks yet, and we will discuss how this can be accomplished. (Received January 22, 2012)

1080-90-157 **Goran Lesaja*** (goran@georgiasouthern.edu), Department of Mathematical Sciences, 203 Georgia Ave, P.O Box 8093, Statesboro, GA 30460. *Infeasible Full-Newton-Step Interior-Point Method for Linear Complementarity Problems.* Preliminary report.

In this talk, we present an infeasible Full-Newton-Step Interior-Point Method for Linear Complementarity Problems. The advantage of the method, in addition to starting from an infeasible starting point, is that it uses

full Newton-steps, thus avoiding the calculation of the step size at each iteration. However, by suitable choice of parameters iterates are forced to stay in the neighborhood of the central path, thus, still guaranteeing the global convergence of the method. The number of iterations necessary to find epsilon-approximate solution of the problem matches the best known iteration bounds for these types of methods. (Received January 23, 2012)

1080-90-160 **Jinglai Shen*** (shenj@umbc.edu), Dept. of Math and Statistics, UMBC, Hilltop Circle 1000, Baltimore, MD 21250. *Spline estimations of constrained functions: Uniform Lipschitz properties*. Preliminary report.

This talk addresses spline estimation of shape constrained functions in statistics and engineering. We will consider two spline estimators: penalized splines (ie P-splines) and smoothing splines. Due to constraints, these spline estimators yield size dependent complementarity conditions that characterize optimal solutions. A critical uniform Lipschitz property is established, and its important implications in asymptotic statistical analysis are discussed. (Received January 24, 2012)

1080-90-169 **Walter Morris*** (wmorris@gmu.edu), Department of Mathematical Sciences, George Mason University, 4400 University Drive, Fairfax, VA 22030. *Linear programs on polytopes combinatorially equivalent to cubes*.

We study linear programs on polytopes combinatorially equivalent to cubes or products of simplices. In particular, we look at their realizations as Markov decision processes, paying particular attention to the discount rate in such representations. (Received January 24, 2012)

91 ► *Game theory, economics, social and behavioral sciences*

1080-91-49 **Maxim Bichuch** (mbichuch@princeton.edu), 118 Sherrerd Hall, Princeton University, Princeton, NJ 08544, and **Stephan Sturm*** (ss Sturm@princeton.edu), 116 Sherrerd Hall, Princeton University, Princeton, NJ 08544. *Portfolio Optimization under Convex Incentive Schemes*. Preliminary report.

We consider the utility maximization problem of terminal wealth from the point of view of a portfolio manager paid by an incentive scheme given as a convex function g of the terminal wealth. The manager's own utility function U is assumed to be smooth and strictly concave, however the resulting utility function $U \circ g$ fails to be concave. As a consequence, this problem does not fit into the classical portfolio optimization theory. Using duality theory, we prove wealth-independent existence and uniqueness of the optimal wealth in general (incomplete) semimartingale markets as long as the unique optimizer of the dual problem has a continuous law. In many cases, this fact is independent of the incentive scheme and depends only on the structure of the set of equivalent local martingale measures. As examples we discuss (complete) one-dimensional models as well as (incomplete) lognormal mixture models. We provide also a detailed analysis of the case when this criterium fails, leading to optimization problems whose solvability by duality methods depends on the initial wealth of the investor. (Received December 21, 2011)

1080-91-286 **Timothy C Reluga*** (treluga@math.psu.edu), Department of Mathematics, McAllister Hall, Penn State University, University Park, PA 16802. *Exact solution of a Differential Population Game for Social Distancing during an Epidemic*. Preliminary report.

In a recent publication, I described the numerical construction of subgame perfect equilibria for a differential population game, where individuals trade off costly social distancing against costly infection during an epidemic. In this talk, I'll present an exact analytic construction of equilibria for the special case of a linear effectiveness function with zero-lower bound. Equilibrium distancing patterns are shown to consist of sequential periods of no action, complete isolation, moderated isolation, and no action, with periods that depend on the basic reproduction ratio, and the amount of time before a vaccine becomes available. This construction provides an upper bound for the performance of all other convex effectiveness functions. In some cases, the overall benefits of social distancing can be sensitive to the tail-shape of the efficacy. (Received January 30, 2012)

92 ► *Biology and other natural sciences*

1080-92-36 **Yi Mao*** (maoyi0@gmail.com), 3720 15th Ave NE S220, Seattle, WA 98195. *Dynamical Basis for Drug Resistance of HIV-1 Protease.*

Background: Protease inhibitors designed to bind to protease have become major anti-AIDS drugs. Unfortunately, the emergence of viral mutations severely limits the long-term efficiency of the inhibitors. The resistance mechanism of these diversely located mutations remains unclear.

Results: Here I use an elastic network model to probe the connection between the global dynamics of HIV-1 protease and the structural distribution of drug-resistance mutations. The models for study are the crystal structures of unbound and bound (with the substrate and nine FDA approved inhibitors) forms of HIV-1 protease. Coarse grained modeling uncovers two groups that couple either with the active site or the flap. These two groups constitute a majority of the drug-resistance residues. In addition, the important residues identified by the dynamical changes in binding and the results agree well with the complete mutagenesis experiment of HIV-1 protease.

Conclusions: The dynamic study of HIV-1 protease elucidates the functional importance of common drug resistance mutations and suggests a unifying mechanism for drug-resistance residues based on their dynamical properties. The results support the robustness of the elastic network model as a potential predictive tool for drug resistance. (Received December 11, 2011)

1080-92-38 **Stanca M Ciupe*** (stanca@math.vt.edu) and **Sarah Hews.** *Mathematical models of immunological tolerance and immune activation following prenatal infection with hepatitis B virus.*

We develop mathematical models that study the role of hepatitis B e antigen in creating immunological tolerance following hepatitis B virus infection and propose explanations for the mechanisms that lead to hepatitis B e antigen clearance, subsequent emergence of potent cellular immune response and liver damage. The dynamics of virus-immune cells interactions are investigated and parameter regimes that allow for viral persistence are derived. Complexity is added to the model to account for mechanism responsible for hepatitis B e antigen loss including seroconversion and mutations in the virus leading to development of hepatitis B e antigen negative virus strains and subsequent activation of CD8 T cells that are specific for such virus. The connection between loss of hepatitis B e antigen and liver injury is investigated in each scenario and predictions about possible disease outcomes are proposed. (Received December 12, 2011)

1080-92-65 **Franziska Hinkelmann, Beverly Delidow and Reinhard Laubenbacher*** (reinhard@vbi.vt.edu), Washington St. (0477), Blacksburg, VA 24061. *WNT signaling in melanoma cells.* Preliminary report.

Experimental evidence suggests that retinoic acid redirects canonical WNT signaling to the PCP pathway in early stage melanoma cells, thereby affecting cell division. More aggressive melanoma cell lines are not responsive to retinoic acid. The question then arises how such a switch in signaling could be affected in these unresponsive cell lines. This talk will discuss a time- and state-discrete mathematical model of the two pathways and its use in identifying potential effectors of a switching mechanism. (Received January 04, 2012)

1080-92-66 **Alan Veliz-Cuba, Kristina Buschur, Rose Hamershock, Ariel Kniss, Esther Wolff and Reinhard Laubenbacher*** (reinhard@vbi.vt.edu), Washington St. (0477), Blacksburg, VA 24061. *Steady state analysis of Boolean network models via a universal class of models.* Preliminary report.

Boolean networks have been used in modeling biological systems to focus attention on the qualitative features of the system, such as the wiring diagram. However, for any wiring diagram, there are multiple Boolean networks associated with it. One way to overcome this issue is to restrict the family of Boolean networks to obtain a one to one correspondence between wiring diagrams and Boolean networks. One such family is the family of AND-NOT networks. In this talk we show that this family is in fact capable of generating all Boolean networks. More precisely, we formally show that any Boolean network can be transformed to an AND-NOT network with similar dynamics. Our results make tools for AND-NOT networks accessible to all Boolean networks and also show that the family of AND-NOT networks is general enough for modeling. Furthermore, previous results combined with those we present here prove that any finite dynamical system can be decomposed into an AND-NOT network. We illustrate our results by applying them to a Boolean model of Th-cell differentiation. (Received January 04, 2012)

- 1080-92-84 **Jane M Heffernan*** (jmheffer@yorku.ca), 4700 Keele St, Mathematics & Statistics, York University, Toronto, Ontario M3J 1P3, Canada, and **Suma Ghosh**. *Characterization of H1N1 pandemic waves under various mitigation strategies.*

Influenza pandemics typically cause multiple waves of morbidity and mortality over a few months or years. The size of these successive waves depends on intervention strategies (i.e. drug therapy and vaccination), mutation, enhanced transmissibility and acquired immunity from previous infections. While antiviral agents are used as a primary control measure during the early stages of a pandemic, both vaccine and drug therapy can be used as preventive control measures in subsequent waves, however, the effects of these control measures in successive waves will be impacted by the existence of acquired immunity from previous waves of infection. The combined effect of drug therapy, vaccination and acquired immunity has not been studied. We have developed a multi-compartmental SIR model of two consecutive waves of an influenza pandemic to characterize disease dynamics under the effects of drug therapy, vaccination and acquired immunity. Using parameter values from the H1N1 pandemic influenza literature, numerical simulations demonstrate that depending on the availability of antivirals and vaccine in the second wave, different treatment strategies should be used in the first wave so as to maximize the acquired immunity in the population. (Received January 11, 2012)

- 1080-92-95 **Hongyu Miao*** (hongyu_miao@urmc.rochester.edu), Saunders Research Building 4134, Dept. of Biostatistics, Univ. of Rochester, 265 Crittenden Blvd, Rochester, NY 14642. *Will Different Types of Models Give Different Answers? A Case Study in Modeling CFSE Data to Understand Immune Cell Life Cycle.*

Carboxy-fluorescein diacetate succinimidyl ester (CFSE) labeling is an important experimental tool for measuring cell responses to extracellular signals in biomedical research. However, changes of the cell cycle (e.g., time to division) corresponding to different stimulations cannot be directly characterized from data collected in CFSE-labeling experiments. A number of independent studies have developed mathematical models as well as parameter estimation methods to better understand cell cycle kinetics based on CFSE data. However, when applying different models to the same data set, notable discrepancies in parameter estimates based on different models has become an issue of great concern. It is therefore important to compare existing models and make recommendations for practical use. For this purpose, we derived the analytic form of an age-dependent multitype branching process model. We then compared the performance of different models, namely branching process, cyton, Smith-Martin, and a linear birth-death ordinary differential equation (ODE) model via simulation studies. Our results suggest that different models do give different answers and we explore the possible explanation. (Received January 13, 2012)

- 1080-92-97 **Jan Medlock*** (jan.medlock@oregonstate.edu), **Martial L. Ndeffo Mbah** and **Alison P. Galvani**. *Optimizing Influenza Vaccine Allocation.*

The emergence of the 2009 H1N1 influenza A strain and delays in production of vaccine against it illustrate the importance of optimizing vaccine allocation. We have developed computational optimization models to determine optimal vaccination strategies with regard to multiple objective functions: e.g. deaths, years of life lost, economic costs. Looking at single objectives, we have found that vaccinating children, who transmit most, is robustly selected as the optimal allocation. I will discuss ongoing extensions to this work to incorporate multiple objectives and uncertainty. (Received January 15, 2012)

- 1080-92-111 **Abdul-Aziz Yakubu*** (ayakubu@howard.edu), Department of mathematics, Howard University, Washington, DC 20059, and **Nianpeng Li**. *Predator Saturation and Mating Limitation Induced Allee Effects In Pacific Halibut and Atlantic Cod Fisheries.*

Fish population models under constant proportion harvest policy (CPP) can help assess performance of exploited fisheries that vary in levels of compensation with or without the Allee effect (depensation). In this talk, we will examine the interactions between CPP, the classic deterministic Beverton-Holt and Ricker stock recruitment model forms, where the Allee effects in the fish population are induced by predator saturation and mating limitation mechanisms. (Received January 18, 2012)

- 1080-92-119 **Zhifu Xie***, Dept. of Mathematics and Computer Sciences, Virginia State University, Petersburg, VA 23806. *Broken chain induced Turing instability in a food chain model.*

In this talk, we present some results on a strongly coupled reaction-diffusion system describing three interacting species in a food chain model, where the third species preys on the second one and simultaneously the second species preys on the first one. We first show that the unique positive equilibrium solution is globally asymptotically stable for the corresponding ODE system. The positive equilibrium solution remains linearly stable for the reaction diffusion system without cross diffusion, hence it does not belong to the classical Turing instability

scheme. We further proved that the positive equilibrium solution is globally asymptotically stable for the reaction diffusion system without cross diffusion by constructing a Lyapunov function. But it becomes linearly unstable only when cross-diffusion also plays a role in the reaction-diffusion system, hence the instability is driven solely from the effect of cross diffusion. Our results also exhibit some interesting combining effects of cross-diffusion, intra-species competitions and inter-species interactions. (Received January 19, 2012)

1080-92-123 **Jemal Mohammed-Awel*** (jmohammedawel@valdosta.edu), jmohammedawel@valdosta.edu. *Modeling screened-refuge technique in agricultural pest control using semi-discrete modeling.* Preliminary report.

Genetically engineered crop plants that produce insecticidal toxins from the bacterium *Bacillus thuringiensis* (Bt) which are toxic to a variety of common agricultural pests were introduced in 1996 and have seen significant and increasing adoption in the intervening for 15 years. A gene from the bacterium *Bacillus thuringiensis* (Bt) has been inserted into the DNA of several crop varieties. This gene codes for the production of a protein highly toxic to many insect pests. However, extensive use of Bt crops entails the risk of promoting development of pest resistance to Bt toxin. The study considers a 'Screened-refuge' technique for sustaining control of insect pests using Bt crops. A model based on semi-discrete/impulsive differential equations is proposed to address the evolution of pest resistance. The mathematical study provide conditions under which a unique globally asymptotically stable equilibrium exists. The conditions are expressed in terms of key model parameters that should help to understand the evolution of pest resistance to Bt crops. (Received January 19, 2012)

1080-92-154 **Colin E. Campbell*** (campbell@phys.psu.edu), **Suann Yang, Katriona Shea and Reka Albert.** *Topological and dynamical analysis of the formation and stability of ecological communities.*

The ability to predict the collapse of ecological communities is of significant concern, in light of global declines in honeybee populations. Here, I will present a recent network-based model of the dynamic process by which mutualistic plant-pollinator communities form. The model replicates observed ecological behavior and gives rise to rich dynamic behavior. I will present a network-theory based analysis of the stability of these communities in the face of species extinctions, and show that some communities are vulnerable to total collapse after the loss of a single species. Existing and novel network measures will be applied to the networks to show that their dynamical behavior can be predicted from their topological properties. Notably, our novel network measures, which assess the abundance, length, and sign of paths between all node pairs, are applicable to any network consisting of positive and negative interactions (edges), and may therefore be applied to network models of a wide range of complex systems. (Received January 23, 2012)

1080-92-155 **Guanyu Wang*** (gwang@gwu.edu), 725 21st Street, N.W., Department of Physics, Washington, DC 20052. *Singularity analysis of cell signaling networks reveals connections between complex diseases.*

Connections between cancer and metabolic diseases may consist in the complex network of interactions among a common set of biomolecules. By applying singularity and bifurcation analysis, the phenotypes constrained by the AKT signaling pathway are identified and mapped onto the parameter space, which include cancer and certain metabolic diseases. By considering physiologic properties (sensitivity, robustness and adaptivity) the AKT pathway must possess in order to efficiently sense growth factors and nutrients, the region of normal responses is located. To optimize these properties, the intracellular concentration of the AKT protein must be sufficiently high to saturate its enzymes; the strength of the positive feedback must be stronger than that of the negative feedback. The analysis illuminates the parameter space and reveals system-level mechanisms in regulating biological functions (cell growth, survival, proliferation and metabolism) and how their deregulation may lead to the development of diseases. The analytical expressions summarize the synergistic interactions among many molecules, which provides valuable insights into therapeutic interventions. In particular, a strategy for overcoming the limitations of mTOR inhibition is proposed for cancer therapy. (Received January 23, 2012)

1080-92-162 **Yang Huang*** (huangyan@mail.nih.gov), 8600 Rockville Pike, Building 38A, 8N811I, Bethesda, MD 20894, and **Geoffrey Siwo, Stefan Wuchty, Michael T Ferdig and Teresa M Przytycka.** *Dissecting interaction map of *Plasmodium falciparum* with symmetric epistasis estimation.*

It is being increasingly recognized that many important phenotypic traits, including various diseases, are governed by a combination of weak genetic effects and their interactions. However, current methods that detect epistatic interactions typically rely on the existence of a strong primary effect, considerably limiting the sensitivity of the search. To fill this gap, we developed a new computational method, SEE (Symmetric Epistasis Estimation),

allowing the genome-wide detection of epistatic interactions without the need for a strong primary effect. The core approach is to search for maximal bipartite cliques in a graph representing available biological information. We applied our approach to progeny crosses of the human malaria parasite *P. falciparum*. We found an abundance of epistatic interactions in the parasite, which gave us a glimpse of its epistatic interaction network. The genome of *P. falciparum* harboured several epistatic interaction hotspots that putatively play a role in drug resistance mechanisms. The abundance of observed epistatic interactions might suggest a mechanism of compensation for the extremely limited repertoire of transcription factors. (Received January 24, 2012)

1080-92-166 **Shernita Lee***, shernita@vt.edu, and **Kahmya McAlpin, Leslie Myint, John Nardini, Christopher Lawrence** and **Reinhard Laubenbacher**. *Discrete Modeling Techniques to Investigate the Innate Immune Response to Respiratory Fungal Pathogens*. Preliminary report.

The fungus, *Aspergillus fumigatus*, dwells in variable environmental conditions and after successful invasion of the host the innate immune response is signaled to eradicate the fungus quickly and efficiently by recruitment of inflammatory cytokines. The element iron is a target for the fungus to meet its nutritional needs, thus the innate immune response attempts to withhold iron and starve the fungus. Lung epithelial cells are a prime target for fungal infection due to constant exposure to airborne pathogens and are the first cells to directly interact with the fungus. We present a mathematical model of iron metabolism in lung epithelial cells and their response to *A. fumigatus* using discrete modeling techniques. The model is capable of making predictions and allows for the testing of conditions that are experimentally intractable, a process beneficial to many fields. (Received January 24, 2012)

1080-92-168 **Peter W Bates*** (bates@math.msu.edu), Department of Mathematics, Michigan State University, East Lansing, MI 48824, **Alex Shingleton**, Zoology Department, MSU, East Lansing, MI 48824, and **Yu Liang**, Mathematics, MSU, East Lansing, MI 48824. *Growth Regulation and the Insulin Signaling Pathway*. Preliminary report.

The insulin signaling pathway is comprised of numerous molecules some of which diffuse, some of which lie on the cell membrane or in its nucleus, but these interact and eventually regulate the activity of the transcription factor FOXO, which is partly responsible for inhibiting the growth of organs. We present a mathematical model of this reacting and diffusing network of molecules and examine the predictions resulting from simulations. (Received January 24, 2012)

1080-92-175 **Ryan Zurakowski*** (ryanz@udel.edu), 140 Evans Hall, Newark, DE 19716, and **Rutao Luo** and **Michael J Piovoso**. *Modeling HIV DNA artifact formation in integrase inhibitor therapy*.

Combination antiretroviral therapy (cART) is able to suppress HIV replication below the standard limit of detection in a majority of HIV-infected patients. Ultrasensitive assays, however, are able to detect virus in almost every patient, at levels between 1 and 50 virions per ml. It is not currently known whether these viruses are from continuing replication or from reservoir cell activation. Integrase inhibitor therapy results in the formation of stable DNA artifacts when continuing replication events are interrupted. We present an ordinary differential equation model of the formation of these artifacts, and discuss how this model can be used to interpret the results of an experiment in which these artifacts were measured following the addition of integrase inhibitors to a group of HIV infected patients. (Received January 25, 2012)

1080-92-188 **Assieh Saadatpour*** (saadat@math.psu.edu), 109 McAllister Building, University Park, PA 16802, and **Reka Albert**. *Boolean and hybrid dynamic modeling of the T-LGL leukemia signaling network*.

T cell large granular lymphocyte (T-LGL) leukemia is a blood cancer characterized by an abnormal increase in the abundance of a type of white blood cell called T cell. As there is no known curative therapy for this disease, identification of potential therapeutic targets is of utmost importance. In the first part of this talk, I will highlight the results of our recent work on how Boolean dynamic modeling with the aid of a network reduction technique is capable of identifying the disease states of the components of the system as well as potential therapeutic targets. In particular, we identified the T-LGL (disease) states of 54 components of the system, 67% of which are corroborated by previous experimental evidence and the rest are novel predictions. In addition, by the dynamic analysis of the underlying network, we identified 19 component perturbations that lead to programmed cell death, thereby suggesting several novel candidate therapeutic targets for future experiments. In the second part of my talk, I will present preliminary results on the comparison of the state space of the Boolean model of

this system with that of the piecewise-linear differential equation (hybrid) model to determine which additional properties can be captured by the hybrid model. (Received January 26, 2012)

1080-92-251 **Shweta Bansal*** (shweta@sbansal.com). *Contact Networks for Modeling Immunizing Infectious Disease Dynamics.*

In models of disease transmission on contact networks, the probability of exposure is determined by the connectivity (degree) of the individual (node). Thus, the most highly connected individuals in a contact network have both a higher probability of spreading infection through the population and a higher rate of exposure (susceptibility) through epidemiological contacts. As an epidemic sweeps through a population, this heterogeneity leads to systematic structural changes in the active portion of the network, removing immunized individuals who no longer participate in the chains of transmission. While the impact of network structure on the progression of an epidemic has been well studied, there has been relatively little work on network evolution during the course of an epidemic. We analytically investigate the impact of epidemic dynamics on the underlying host population structure and find that the structural evolution of the network varies with the original topology of the network and the contagiousness of the disease. We identify the mechanisms acting on the network topology to make them sparser, consider questions about the patterns of immunity that arise during disease outbreaks, and explore their impact on future epidemics and key public health policies. (Received January 29, 2012)

1080-92-258 **Yoo-Ah Kim, Jozef H Przytycka, Stefan Wuchty and Teresa M Przytycka***, przytyck@ncbi.nlm.nih.gov. *From Genotype to Phenotype - network biology approach.*

New experimental techniques facilitating genome-wide measurements of various molecular quantities provide us with an unprecedented opportunity to gain new insights into functioning of cellular systems and help explaining the relation between genotype and phenotype. In particular, we would like to understand how the genotypic changes are propagated along molecular pathways. On one hand, in complex diseases, different genotypic perturbations often lead to the same disease phenotype presumably dys-regulating the same pathways of the cellular system. On the other hand, there are numerous examples where the impact of a large genotypic change such as gene copy number variations appears to be “buffered” and has no apparent phenotypic effect. I will discuss systems level approaches, combining various types of experimental data, statistical data analysis, and new graph theoretical and algorithmic techniques developed by our group in the quest to address these questions. (Received January 29, 2012)

1080-92-266 **David Murrugarra*** (davidmur@vt.edu), Virginia Bioinformatics Institute, Blacksburg, VA 24060. *Stochastic Discrete Dynamical Systems.*

This talk will introduce a new modeling framework for gene regulatory networks. This framework incorporates propensity parameters for activation and degradation and is able to capture the cell-to-cell variability. It will be presented in the context of finite dynamical systems, where each gene can take on a finite number of states and where time is a discrete variable. One of the new features of this framework is that it allows a finer analysis of discrete models and the possibility to simulate cell populations. An application will be presented using one of the best known stochastic regulatory networks, that is involved in controlling the outcome of lambda phage infection of bacteria. (Received January 29, 2012)

1080-92-267 **Sivan Leviyang*** (sr286@georgetown.edu). *HIV Infection and Random Partitions.*

In this talk I will describe a connection between theoretical work involving random partitions and the population genetics of HIV infection. During HIV infection, attack by the immune system through CTLs produces HIV escape dynamics. Understanding the impact of such escape dynamics on the genetic diversity of the infecting HIV population requires the construction of genealogies. The construction of such genealogies can be reduced to the characterization of random partitions. (Received January 29, 2012)

1080-92-292 **Sourya Shrestha***, Department of Ecology & Evolutionary Biology, 2019 Kraus Natural Science Building, 830 North University Avenue, Ann Arbor, MI 48109, and **Betsy Foxman and Pejman Rohani**. *Influenza-pneumococcal interaction.*

Polymicrobial infections, where multiple pathogens interact synergistically/antagonistically in the manifestation of the infection, are common. Co-circulating pathogens influenza virus and pneumococcus bacteria is an important example. Interactions can be central to clinical outcome of the infection, and the epidemiology of one or both. Typically, interactions are studied at two different scales; at the host level in a lab setting, and at the population level in epidemiological data. Experiments in animal models show evidence for strong interaction whereas recent epidemiological studies find only a modest association between the two. Insofar, the understanding at the two levels are discordant. We take a two-pronged approach of quantifying the viral-bacterial interaction at

two different scales. First, based on the understanding of kinetics of pathogen-specific immunological dynamics, we construct a within-host model of viral-bacterial interaction that quantifies its timing and intensity. Second, we use a likelihood-based method to infer interaction at the population level in epidemiological data. By taking them together, we strive for a more holistic understanding of the interaction and its consequences for clinical care, pneumococcal epidemiology and pandemic preparedness. (Received January 30, 2012)

1080-92-309 **Jesse W Cotari, Guillaume Voisinne, Orly Evendar, Volkan Karabacak and Grégoire Altan-Bonnet***, Box 460 - 1275 York Avenue, ImmunoDynamics group, Memorial Sloan-Kettering Cancer Center, New York, NY 10025. *Single-Cell Heterogeneity Analysis: a computational methodology to quantify the phenotypic variability of isogenic cells*. Preliminary report.

The construction of biochemical models of cellular signaling networks requires the assimilation of a large number of kinetic constants from diverse sources. In this work, we present an experimental and modeling methodology that integrates novel, cell system-specific sensitivity measurements with published kinetic constants.

We have applied this methodology to quantify the interactions between receptors for the cytokines IL-2 and IL-7 in T lymphocytes. Using our method of heterogeneity analysis, we demonstrate that responsiveness to IL-7 is negatively correlated with expression of the IL-2 receptor α chain (IL-2R α) in T cells: cells with higher levels of IL-2R α have a 50-fold lower sensitivity compared to cells expressing lower levels.

We have constructed a computational model of the interactions in this biochemical system. To fit the model to our high-resolution data, we have employed a Bayesian framework that penalizes for deviation from both previously defined parameter values and the current data. Using this fitting algorithm, we identify the competition for the shared γ receptor as a mechanism for non-independence of IL-2 and IL-7 sensitivity. Implications for the differentiation memory T cells during an immune response are discussed. (Received January 30, 2012)

1080-92-357 **Jing Li***, Department of Mathematics, Pennsylvania State University, University Park, PA 16802, and **Timothy C Reluga**, Department of Mathematics, Pennsylvania State University, University Park, PA 16802. *A mixed-strategy game theoretical approach for infectious disease prevention by social distancing*. Preliminary report.

In this talk, we describe a population game in which individuals are allowed to decide between adopting different social distancing strategies with the goal of lowering the infection risk and maximizing payoffs. When the reduction in infection risk is a convex function of the cost of social-distancing investment, there is a unique pure-strategy game equilibrium. When the reduction in infection risk is not convex —e.g., when the infection risk reduction function is a decreasing function of social-distancing with the property that the concavity changes once— a trivial social-distancing strategy is a global Nash equilibrium for lower cost of infection and a positive social-distancing strategy is a global Nash equilibrium for higher cost of infection. The case for intermediate level cost of infection is more complicated since there are two local Nash equilibria which allows an individual to make a choice between these two Nash equilibria. Therefore, a mixed strategy is one of the possible solutions as a global Nash equilibrium. (Received January 31, 2012)

1080-92-366 **Yongwu Rong*** (rong@gwu.edu), Department of Mathematics, George Washington University, Washington, DC 20052, and **Rahul Simha, Guanyu Wang and Chen Zeng**. *Dynamics and Topology of Boolean Networks*.

A Boolean network consists of a collection of units with a time-discrete dynamical system on two states. The interactions between the units are represented by the topology of a graph. An interesting problem is to study the connection between topology and dynamics of such networks. In particular, the so called reverse engineering problem asks for the topology of the network given information on its dynamics.

We focus on a specific Boolean network model arisen from the study of gene regulatory networks. Under this model, the reverse engineering problem is naturally related to the Satisfiability Problem. We show that (1) given information on dynamics, there is a polynomial time algorithm that determines if such a networks exists, and (2) the problem of finding a minimal such network is NP-hard. (Received January 31, 2012)

97 ► Mathematics education

1080-97-12 **Ningjun Ye*** (ye_ningjun@yahoo.com), 14 Summer Place, Hattiesburg, MS 39402, and **Sherry Herron** (sherry.herron@usm.edu). *Assessing the Impact of a Computer-based College Algebra Course*.

University of Southern Mississippi piloted the Math Zone in Spring 2007, a computer-based program in teaching MAT 101 and MAT 099 in order to improve student performance. Based on student data from fall semester of

2007 to spring semester of 2010, this research determined the effect of the re-design of MAT 101 on student achievements in comparison to a traditional approach to the same course. Meanwhile, the study investigated possible effects of the Math Zone program on students' attitude toward studying mathematics. This study showed that there was no statistically significant difference on MAT101 final exam scores between the Math Zone students and the Classroom students in Fall 2007, Spring 2008 and Fall 2008. At the same time, the study also showed that there was no statistically significant difference in students' attitude toward math between the two groups in each of the three semesters. However, this study revealed a significant relationship between the hours the students spent in the Math Zone and the scores they made on the final exam in Spring 2008, Fall 2008, Spring 2009, Spring 2010, and Spring 2011. (Received October 11, 2011)

1080-97-13 **Kurt Kreith*** (kkreith@ucdavis.edu). *Moving Beyond Exponential Growth and Malthus in Secondary School Curricula*. Preliminary report.

In teaching exponential growth, it is common to make passing reference to Malthus and his controversial writings of 200 years ago. This raises the question of whether, in the context of secondary school mathematics, one can address human population dynamics more meaningfully than such a cursory treatment suggests. By way of moving in this direction, basic matrix arithmetic can be combined with mathematical ideas going back to Fibonacci to model populations while taking cohorts, delays, and diffusion into account. (Received October 14, 2011)

1080-97-45 **Ilhan M. Izmirlı*** (iizmir12@gmu.edu), GMU, Department of Statistics, 4400 University Drive, MS 4A7, Fairfax, VA 22030. *Radical Constructivism and Pedagogy of Mathematics*. Preliminary report.

In this paper we will discuss the impact of radical constructivism on the pedagogy of mathematics.

It is our view that the most vital aspect of radical constructivist pedagogy of mathematics is that by instituting an academic discourse where students routinely create mathematics themselves, it makes one of the most fundamental tenets of pedagogy (namely, students coming to believe that they have possession of the material they have learned) compellingly germane. Moreover, such a milieu, where prolific social and linguistic interaction is the norm, would be an excellent conduit for the learners' further academic development.

This paper is organized in three sections. In the first section we will discuss the basic tenets of the constructivist epistemology. This will be followed by a brief depiction of radical constructivism. In the last section we will delineate some facets of a radical constructive pedagogy of mathematics. (Received December 16, 2011)

1080-97-180 **Kathleen M Clark*** (kclark@fsu.edu), Florida State University, School of Teacher Education, 1114 West Call Street, Tallahassee, FL 32306-4459. *Historical Problems and Problem Solving: Potential Contributions to Mathematical Knowledge for Teaching*. Preliminary report.

Examining prospective secondary mathematics teachers' (PSMTs') efforts when they study the history of mathematics provides opportunities to determine whether their mathematical knowledge for teaching (MKT) is enhanced. In an effort to begin an investigation of this sort, I implemented a 'problem solving portfolio' assignment in a history of mathematics course to capture ways in which PSMTs engaged in solving problems found in historical sources during a history of mathematics course. Each PSMT selected ten problems that they previously solved in the course, presented their solution to each problem, and provided a reflection on how their work on each problem contributed to the ways that they considered the underlying mathematics addressed in the problem. In this talk I will share several of the problems that were most often selected by the PSMTs and highlight the common themes raised by them in their reflections. These themes will be used to construct a preliminary model of how such problem solving can contribute to MKT. (Received January 25, 2012)

LAWRENCE, KS, March 30–April 1, 2012

Abstracts of the 1081st Meeting.

00 ► General

1081-00-156 **Joshua Ericson*** (jericson@ksu.edu), **Pietro Poggi-Corradini** and **Hainan Zhang**.
Epidemic distance versus effective resistance. Preliminary report.

We introduce a new graph quasi-metric, the *epidemic distance*, which captures the distance between two nodes in a graph with respect to the spread of a virus. We compare the epidemic distance with the metric obtained from effective resistance on a graph; with the aim of showing that they are essentially the same. We believe that reweighting the edges of a graph with their respective epidemic distances will allow clustering algorithms to obtain results that are more accurate. (Received February 08, 2012)

1081-00-388 **Christopher Seidholz*** (cseidholz@gmail.com), 1635 S 16th St, Lincoln, NE 68502, and
Cale Hadan, **Corrine Hodges** and **Alex Houston**. *Exploring the Efficient Frontier: An Inquiry into the Investment Policy of the City of Lincoln*.

The purpose of this paper is to empirically determine (using Modern Portfolio Theory) whether changes in the investment policy of the City of Lincoln, Nebraska would improve investment outcomes. More precisely, we will apply the Mean-Variance Model proposed by Harry Markowitz (1952) to a less restrictive investment policy and compare the results with those produced by Kanno and Yamazaki's Mean-Absolute Deviation Model (1991). In doing so, we hope to assess the efficacy of the City's investment strategy. Implementation of these models and comparisons to real historical investment data reveal that the City of Lincoln can expect greater returns through portfolio diversification within the current policy, while expanding the policy to include riskier assets is an unwise strategy. (Received February 14, 2012)

05 ► Combinatorics

1081-05-4 **Catherine Yan*** (cyan@math.tamu.edu), Department of Mathematics, Texas A&M
University, MS 3368, College Station, TX 77843-3368. *Enumerative combinatorics with fillings of polyominoes*.

An important and active area of Enumerative Combinatorics is the study of combinatorial statistics, which are simply functions from the combinatorial objects to the set of non-negative integers. Many interesting statistics have been investigated over families of combinatorial structures, such as permutations, words, matchings, set partitions, integer sequences, graphs, and multi-graphs. We introduce a new combinatorial model—fillings of polyominoes, which provides a unified approach to the classical combinatorial analysis on all the above mentioned structures.

A polyomino is a shape made by connecting certain numbers of equal-sized squares, each jointed together with at least one other square along an edge. The combinatorial model used here is obtained by assigning a non-negative integer to each square of the polyomino. It allows us to apply various algebraic tools and combinatorial transformations. In this talk I will demonstrate how to use this model to analyze some combinatorial statistics, such as the inversions (and their variations), the major index, and the longest monotone substructures. (Received February 10, 2012)

1081-05-8 **Sarah Crown Rundell*** (rundells@denison.edu), Department of Math and Computer
Science, Denison University, 100 West College St, Granville, OH 43023. *The Coloring Complex of a Hypergraph*.

Let G be a simple graph with n vertices and at least one edge. The coloring complex $\Delta(G)$ was defined by Steingrímsson, and is a simplicial complex that is associated to G whose r -faces consist of all ordered set partitions $[B_1, \dots, B_{r+2}]$ of the vertices of G so that at least one of the B_i contains an edge of G . Jonsson showed that $\Delta(G)$ is a constructible complex, and the rank of the unique nontrivial homology group is $|\chi_G(-1)| - 1$, where $\chi_G(\lambda)$ denotes the chromatic polynomial of G .

Let H be a hypergraph with n vertices. In this talk, we define the coloring complex of a hypergraph, $\Delta(H)$, and we will discuss its homology. In particular, in the case where the hypergraph is a complete k -uniform hypergraph, $\Delta(H)$ is a shellable complex, and the rank of its unique nontrivial homology group can be expressed in terms of

the chromatic polynomial of H . Further, using the Eulerian idempotents, one can place a decomposition on this nonzero homology group, and the rank of the j^{th} component in this decomposition equals the absolute value of the coefficient of λ^j in the chromatic polynomial of H . (Received September 28, 2011)

1081-05-24 **Mirkó Visontai*** (mirko@math.upenn.edu). *On the joint distribution of descents and inverse descents*. Preliminary report.

Let $D(\pi)$ denote the number of descents in a permutation π . A conjecture of I. Gessel asserts that the joint generating polynomial of descents and inverse descents

$$\sum_{\pi \in \mathfrak{S}_n} s^{D(\pi^{-1})} t^{D(\pi)}$$

admits a decomposition into a sum of the form

$$\sum_{i,j} \gamma_{n,i,j} (st)^i (s+t)^j (1+st)^{n+1-j-2i}$$

where the coefficients $\gamma_{n,i,j}$ are nonnegative integers.

In this talk, we give a recurrence satisfied by these coefficients, which brings us a step closer to resolving the conjecture. (Received December 20, 2011)

1081-05-35 **Bruce E Sagan*** (sagan@math.msu.edu), Department of Mathematics, Michigan State University, East Lansing, MI 48105. *Permutation Patterns and Statistics*.

Let S_n denote the n th symmetric group. Consider the set of permutations $\text{Av}_n(\pi) = \{\sigma \in S_n : \sigma \text{ avoids } \pi\}$ where avoidance is taken in the sense of pattern theory. Also consider any permutation statistic $\text{st} : S_n \rightarrow \mathbb{N}$. In this talk, we will combine the notions of permutation patterns and permutation statistics by considering the generating functions $F_n(\pi) = \sum_{\sigma \in \text{Av}_n(\pi)} q^{\text{st}\sigma}$. In particular, we investigate these polynomials for the inv and maj statistics. They turn out to have many wonderful properties, giving a strengthening of the concept of Wilf equivalence, q -analogues of the Catalan numbers and other well-known sequences, and connecting pattern avoidance with other parts of combinatorics such as the theory of integer partitions.

This is joint work with Ted Dokos, Tim Dwyer, Brian Johnson, and Kim Selsor. (Received January 11, 2012)

1081-05-45 **J. Haglund*** (jhaglund@math.upenn.edu), 209 S. 33rd. St., Math. Dept., Philadelphia, PA 19104-6395. *Parking Functions in the Representation Theory of Diagonal Harmonics*. Preliminary report.

We discuss two different families of conjectures, each involving a different generalization of parking functions, which have arisen from the study of the representation theory of Diagonal Harmonics. (Received January 16, 2012)

1081-05-74 **Tai Hà, Erik Stokes and Fabrizio Zanello*** (zanello@math.mit.edu), Department of Mathematics, Michigan Tech, Houghton, MI 49931. *On Stanley's matroid h -vector conjecture*.

A horrendously difficult 1977 conjecture of Richard Stanley's simply states that all matroid h -vectors are pure O -sequences. In this talk, I will describe a new and more abstract approach, developed in collaboration with T. Hà (Tulane) and E. Stokes (NSA), whose goal is to translate a substantial portion of the problem into one on the structural properties of pure O -sequences. We will rely in part on the recent progress on pure O -sequences, and will not need to construct explicitly a pure monomial order ideal for each given matroid h -vector, as often done in the past.

Using this approach and the Interval Property for socle degree 3 pure O -sequences (proved by M. Boij, J. Migliore, R. Miró-Roig, U. Nagel and myself in an upcoming AMS Memoir), I will outline a solution to Stanley's conjecture for matroids of rank at most 3. I will wrap up the talk discussing a possible approach to the general case of the conjecture. (Received January 30, 2012)

1081-05-78 **Samuel K. Hsiao***, Bard College, Mathematics Program, Annandale-on-Hudson, NY 12504. *Peaks and the cd-index*. Preliminary report.

The chain enumerative data of a convex polytope, and more generally a regular CW-sphere, is compactly represented by its cd -index. Though the cd -index is known to be non-negative for all regular CW-spheres, a general combinatorial interpretation has been elusive. We look at conditions under which the cd -index can be interpreted as enumerating peak sets and discuss the construction of spheres for which these conditions hold. (Received January 30, 2012)

1081-05-119 **Heinrich Niederhausen*** (niederha@fau.edu), Florida Atlantic University, 777 Glades, Boca Raton, FL 33431. *Ballot Paths Avoiding both Patterns $urru$ and rur .*

A ballot paths is a lattice walk that takes unit up steps, u , and unit right steps, r . It begins at $(0, 0)$, stays weakly above the diagonal, and ends at (n, m) , where $m \geq n \geq 0$. The number of such paths $s_n(m)$ that neither contain the pattern rur nor the pattern $urru$ has the generating function

$$\sum_{n \geq 0} s_n(n+m) t^n = (1+t^2) \left(\frac{1+t^2+t-\sqrt{1-t(1+t)(3t^2-t+2)}}{2(t+t^3)} \right)^{m+1}.$$

We derive this generating function from the recursion for $s_n(m)$ by applying the Finite Operator Calculus (Rota 1973). Actually, this calculus primarily derives a polynomial expression for $s_n(m)$; the generating function only comes as a by-product. This work was inspired by work of Sapounakis, Tasoulas, and Tsikouras (2007). Early work on patterns goes back to Guibas and Odlyzko (1981). (Received February 05, 2012)

1081-05-142 **Gábor Hetyei*** (ghetyei@unc.edu), Department of Mathematics and Statistics, UNC Charlotte, Charlotte, NC 28223. *The short toric polynomial and the toric h -vector of a simple polytope.*

We introduce a new toric polynomial associated to a graded Eulerian poset. This polynomial contains the same information as Stanley's toric polynomials, but allows different algebraic manipulations. Stanley's intertwined recurrence may be replaced by a single recurrence, in which the degree of the discarded terms is independent of the rank. We state the short toric variant of the formula by Bayer and Ehrenborg, expressing the toric h -vector in terms of the cd -index. The new formula may be stated in a rank-independent form, and it may be shown using weighted lattice path enumeration and the reflection principle. We use our techniques to derive a formula expressing the toric h -vector of a dual simplicial Eulerian poset in terms of its f -vector, thus answering a question stated by Kalai in the 1980-ties. (Received February 07, 2012)

1081-05-149 **Miklos Bona*** (bona@uf1.edu), Department of Mathematics, Univ. of FL, Little Hall, Gainesville, FL 32611-8105. *Surprising symmetries in objects counted by Catalan numbers.*

Let $S_{n,132}(q)$ be the number of all copies of the pattern q in all 132-avoiding permutations of length n . We provide a large class of pairs q and q' for which $S_{n,132}(q) = S_{n,132}(q')$ and the equality is non-trivial. In particular, our statistics, while having the same cumulative value, are *not* equidistributed. The proofs depend on some transformations in another class of objects counted by Catalan numbers, namely binary plane trees. (Received February 08, 2012)

1081-05-166 **Shane Scott*** (scottsha@ksu.edu), 2406 6th Ave, Dodge City, KS 67801, and **Francine Blanchet-Sadri** and **Andrew Lohr**. *Pattern Avoidance in Partial Words*. Preliminary report.

A partial word is a sequence of symbols from a finite alphabet that may have some undefined positions, called holes, that match every letter of the alphabet. Partial words are said to meet a pattern if they contain a subword which matches the homeomorphic image of a word, called the pattern. The conditions governing the inevitability or avoidability of patterns in words has long been of interest to computer science. We extend this study into the case of partial words. In particular, we discuss the avoidability index (the size of the minimal alphabet which can avoid a pattern) and methods we have used for determining the avoidability indices of all binary and most ternary patterns. (Received February 09, 2012)

1081-05-253 **Jacob A White*** (jawhite@msri.org). *Complexes of Signed Graphs and Decision Trees*. Preliminary report.

We introduce some simplicial complexes arising in the study of signed graphs. We shall also give an overview of the decision-tree approach to discrete Morse theory. The main goal is to show how constructing decision trees can be used to determine the homotopy type of a complex. The main object of study is the complex of 'balanced' signed graphs. As an application, we give a new recurrence relation for the number of spheres in the complex of bipartite subgraphs. (Received February 13, 2012)

1081-05-296 **Art M Duval** (artduval@math.utep.edu), **Caroline J Klivans** (caroline_klivans@brown.edu) and **Jeremy L Martin*** (jmartin@math.ku.edu). *Cuts and flows in cell complexes, II: Lattices and critical groups.*

The critical group of a graph is a finite abelian group whose order is the number of spanning trees, and which can be constructed in several different ways from the cut and flow lattices of the graph. We extend the constructions of these groups from graphs to cell complexes, and introduce the cocritical group of a complex. We show that in the higher-dimensional case, these groups are not necessarily isomorphic, but are related by short exact

sequences with error terms given by torsion homology. Some of the motivation for considering cuts and flows will be presented in the talk by A. Duval, but this talk will still be self-contained and independent of that talk. (Received February 13, 2012)

1081-05-297 **Art Duval*** (artduval@math.utep.edu), University of Texas at El Paso, Department of Mathematical Sciences, 500 W. University Ave., El Paso, TX 79968-0514, and **Caroline Klivans** and **Jeremy Martin**. *Cuts and flows in cell complexes, I: Topology and vector space bases*. Preliminary report.

The cut and flow spaces of a graph are vector spaces with combinatorially explicit bases given by the characteristic vectors of fundamental bonds and fundamental cycles, respectively, of a fixed spanning tree of the graph. We use matroid theory to extend the construction of these spaces from graphs to cell complexes, and interpret the higher-dimensional bonds and cycles topologically. We form explicit bases for the cut and flow spaces from the (algebraic) characteristic vectors of fundamental bonds and fundamental cycles, respectively, of a fixed cellular spanning tree of the cell complex. The $+1$'s and -1 's that occur in the characteristic vectors of cycles and bonds in the graph-theoretic case are replaced in the more general setting with coefficients of torsion homology. Cut and flow lattices will be considered in the talk by J. Martin. (Received February 13, 2012)

1081-05-300 **Christine E Heitsch*** (heitsch@math.gatech.edu), Georgia Institute of Technology, School of Mathematics, Atlanta, GA 30332. *Meanders and RNA Folding*.

A closed meander of order n is a non-self-intersecting closed curve in the plane which crosses a horizontal line at $2n$ points. Meanders occur in a variety of settings from combinatorial models of polymer folding to the Temperley-Lieb algebra, yet the exact meander enumeration problem remains open. Building on results for plane trees and noncrossing partitions motivated by the biology of RNA folding, we prove that meanders are connected under appropriately defined local move transformations. The resulting meander graphs have some interesting characteristics and suggest new approaches to the enumeration question. As we will explain, meanders also relate to the challenging biomathematical problem of comparing different possible folds for an RNA sequence. (Received February 13, 2012)

1081-05-316 **Julian Moorehead** and **Michelle L Wachs*** (wachs@math.miami.edu). *A new q -analog of the partition lattice*. Preliminary report.

We introduce a new q -analog of the partition lattice based on decompositions of the n -dimensional vector space over the field with q elements. This poset is shown to be shellable with Möbius invariant equal to the q -analog $[n-1]_q!$ of $(n-1)!$ times a polynomial in q that reduces to 1 when q is set equal to 1. Our q -analog is a special case of a more general construction involving decompositions of matroids. (Received February 13, 2012)

1081-05-350 **John Shareshian** and **Russ Woodroffe*** (russw@math.wustl.edu). *Noncontractibility of the coset lattice of a finite group*.

The coset lattice of a finite group G consists of the empty set together with all cosets of all subgroups of G , ordered by inclusion. Ken Brown has asked whether there is any group such that the order complex of the (proper part of the) coset lattice is contractible. We show that the answer is “no” for a large class of groups satisfying certain divisibility conditions on the index of every subgroup. We also show that the answer is “no” for alternating and symmetric groups, by explicitly constructing homology cycles. (Received February 14, 2012)

1081-05-369 **Svetlana Poznanovikj*** (svetlana@math.gatech.edu). *Cycles and sorting index for permutations and matchings*.

We define cycles and sorting index for matchings in a way that generalizes the cycles and the sorting index for permutations. Using a bijection with weighted Dyck paths we show that this pair of combinatorial statistics has the same distribution as a pair of statistics on matchings defined in terms of nestings. This in turn allows us to refine known results about permutations. (Received February 14, 2012)

1081-05-371 **Alexander Burstein*** (aburstein@howard.edu), Department of Mathematics, Howard University, Washington, DC 20059. *Dumont permutations with one occurrence of certain 3- and 4-letter patterns*. Preliminary report.

We enumerate the sets of Dumont permutations of the first and second kinds containing exactly one occurrence of certain three and four letter patterns. In some cases, we determine the cycle structure of those elements. (Received February 14, 2012)

1081-05-402 **hoda bidkhori***, 23 Elm Street, Apt 303, somerville, MA 02143. *Lattice Path Matroid Polytopes*.

Fix two lattice paths P and Q from $(0, 0)$ to (m, r) that use East and North steps with P never going above Q . Bonin et al. in [?] show that the lattice paths that go from $(0, 0)$ to (m, r) and remain bounded by P and Q can be identified with the bases of a particular type of transversal matroid, which we call it a lattice path matroid.

In this paper, we consider properties of lattice path matroid polytopes. These are the polytopes associated to the lattice path matroids. We investigate their face structure, decomposition, triangulation, Ehrhart polynomial and volume. (Received February 15, 2012)

06 ► *Order, lattices, ordered algebraic structures*

1081-06-192 **Maciej Niebrzydowski*** (mniebrz@gmail.com). *Preordered quandles*. Preliminary report. We consider the theory of preordered quandles, their homology, and geometric applications. (Received February 11, 2012)

11 ► *Number theory*

1081-11-1 **Frank Calegari*** (fcale@math.northwestern.edu). *Studying algebraic varieties through their cohomology—Recent progress in the Langlands program*

An algebraic variety X over (the rational numbers) \mathbb{Q} is given by a system of polynomial equations with coefficients in \mathbb{Q} . The structure of X over \mathbb{Q} imbues the cohomology groups of X with extra symmetries coming from Galois automorphisms. Given a vector space V with an action of the Galois group, we discuss the problem of whether V arises as the cohomology of some variety X . We shall particularly emphasize the case of curves. (Received March 31, 2011)

1081-11-71 **Charles L Samuels*** (clsamuels@okcu.edu), Oklahoma City University, Department of Mathematics, 2501 North Blackwelder, Oklahoma City, OK 73106. *Two Inequalities relating the classical and areal Mahler measures*.

Recent work of I. Pritsker studies an areal version of the Mahler measure. Among other observations, he provides a sequence of polynomials over \mathbb{Z} whose areal Mahler measures tend to 0, meaning that the analog of Lehmer's conjecture is false. In his examples, however, the Mahler measures are all quite large. We give new upper and lower bounds on the areal Mahler measure in terms of the classical Mahler measure which, in part, explain this phenomenon. Our inequalities improve two of Pritsker's inequalities in the case where the Mahler measure is small. This work is joint with K.K. Choi. (Received January 29, 2012)

1081-11-398 **Zhiwei Yun*** (zyun@math.mit.edu), 77 Massachusetts Avenue, Room 2-173, Cambridge, MA 02139. *Geometric Langlands and the inverse Galois problem*.

The Inverse Galois Problem concerns with realizing a particular finite group as a Galois group of some extension of \mathbb{Q} . We will show how to solve this problem for certain exceptional Lie type groups (such as $E_8(p)$) using ideas from automorphic forms and geometric Langlands. (Received February 14, 2012)

13 ► *Commutative rings and algebras*

1081-13-17 **Paolo Mantero*** (pmantero@math.purdue.edu), 150 N University St, West Lafayette, IN 47907-2067. *An approach to study the liaison classes of non-licci ideals*. Preliminary report.

A vast part of literature on CI-linkage has addressed questions relative to the most relevant, and well-behaved, class of ideals in linkage, that is, licci ideals. However, for non-licci ideals of height more than two the following basic question is still open: in their even linkage classes is it possible to find ideals having the best homological properties? In this talk, we answer this question in the positive (under reasonable assumptions). More generally, we present an approach to study the linkage class of non-licci ideals based on the introduction of ideals playing a role (in their even linkage class) similar to the one played by complete intersections for licci ideals. These ideals (that are essentially unique) minimize homological invariants (Betti numbers and multiplicity) and have the best homological properties among all the ideals in their even linkage class. Ideals generated by Pfaffians or minors, rigid isolated singularities, ideals of fat points, powers of complete intersections, ideals of minimal multiplicity, are proved to be the minimal representatives of their even linkage classes. (Received November 30, 2011)

1081-13-19 **Sankar P Dutta*** (dutta@math.uiuc.edu), University of Illinois, Department of Mathematics, 1409 W. Green Street, Urbana, IL 61801. *On Efficient Generation of Pull-back of $T_{\mathbb{P}^n}(-1)$* . Preliminary report.

Let $f : X \rightarrow \mathbb{P}^n$ be a proper map such that dimension of $f(X) \geq 2$. We address the following question: Is $\dim H^0(X, f^*(T_{\mathbb{P}^n}(-1))) = n + 1$? We provide an affirmative answer under standard mild restrictions on X . We also point out that this provides an affirmative answer to a similar question raised via regular alteration of a closed subvariety in a blow-up of a regular local ring at its closed point in the mixed characteristics. (Received December 16, 2011)

1081-13-25 **Jared L Painter*** (jlpainter@uta.edu), 411 S. Nedderman Drive, 478 Pickard Hall, Arlington, TX 76019-0408. *Classification of the Tor Algebra for Trivariate Monomial Ideals*. Preliminary report.

Recently, L. Avramov classified the behavior of Bass numbers of embedding codepth 3 commutative local rings. His classification relied on a corresponding classification of their respective Tor algebras, which is comprised of 5 categories. In this talk we explore the algebra structure of $A = \text{Tor}^R(\mathbb{k}, R/I)$, where $R = \mathbb{k}[x, y, z]$ is a trivariate polynomial ring over a field \mathbb{k} and I is a monomial ideal primary to the homogeneous maximal ideal \mathfrak{m} of R . We will determine which of the 5 categories of Tor algebras can be realized by monomial ideals. In addition we will classify trivariate monomial ideals of embedding codepth 3 by their Tor algebra structure, and find previously unknown examples in certain classes. (Received December 20, 2011)

1081-13-50 **Hans Schoutens*** (hschoutens@citytech.cuny.edu), 365 Fifth Ave, Department of Mathematics, CUNY Graduate Center, New York, NY 10016. *Classifying singularities up to analytic extensions*.

One of the main goals of algebraic geometry is to classify all varieties up to a natural equivalence relation, like being birational or isomorphic. Likewise, commutative algebra tries to classify Noetherian (local) rings. To this end, local and global invariants, moduli spaces, zeta series, ... are introduced, with the expectation that they will lead to a complete set of invariants. But how feasible is such a program? Before we can even ask this question, we need to define 'feasible'. Descriptive set-theory declares it to mean 'being classifiable by a real-valued Borel invariant'. Clearly, this point of view is alien to the field, and so no such Borel invariants are readily available. I will show nonetheless that in this sense, classifying Noetherian local rings up to analytic extensions is a feasible problem. The solution, unfortunately, as it uses ultraproducts, is totally ineffective. Yet, I will give some hints on how to potentially turn this into something more concrete. (Received January 18, 2012)

1081-13-52 **Adam Van Tuyl*** (avantuyl@lakeheadu.ca), Department of Mathematical Sciences, Lakehead University, Thunder Bay, ON P7B5E1, Canada, and **Stefan Tohăneanu**. *The minimum distance of linear codes and fat points*.

Let $A(Z)$ be the generating matrix of some linear code with parameters $[s, n + 1, d]$ over an arbitrary field K . I will describe how to associate to $A(Z)$ a set of fat points in $Z \subseteq \mathbb{P}^n$. I will then show that d , the minimal distance of the code, is bounded below by specific shifts in the graded minimal free resolution of I_Z , the defining ideal of Z . We give better bounds in the case that the support of Z is a complete intersection. This is joint work with Ștefan O. Tohăneanu (Western). (Received January 18, 2012)

1081-13-53 **Janet Cowden Vassilev*** (jvassil@math.unm.edu), Department of Mathematics and Statistics, University of New Mexico, Albuquerque, NM 87131. *P-bounded closure operations and semiprime operations on the nodal curve*. Preliminary report.

In previous work, the speaker defined bounded closure operations. We discuss a new notion: P -bounded closure operations and we use these operations to aid in classifying the semiprime operations on the nodal curve $R = k[[x, y]]/(xy)$. (Received January 20, 2012)

1081-13-76 **Tai Ha*** (tha@tulane.edu), Tulane University, Department of Mathematics, New Orleans, LA 70118. *Stabilization of multigraded Betti numbers*.

Let G be a finitely generated abelian group, let S be a G -graded polynomial ring over a base ring A . Let I be a G -homogenous ideal in S and let M be a finitely generated G -graded S -module. In this talk, we shall discuss the asymptotic linear behavior of multigraded (or G -graded) Betti numbers of MI^t , as t gets large. (Received January 30, 2012)

1081-13-113 **Hailong Dao** (hdao@math.ku.edu), Department of Mathematics, University of Kansas, Lawrence, KS 66045-7523, and **Ryo Takahashi*** (takahasi@math.shinshu-u.ac.jp), Department of Mathematics, University of Nebraska, Lincoln, NE 68588-0130. *The dimension and radius of a subcategory of modules.*

Let R be a commutative noetherian local ring, and let $\text{mod } R$ denote the category of finitely generated R -modules. As analogues of the dimension of a triangulated category defined by Rouquier, we introduce the dimension and radius of a subcategory of $\text{mod } R$. When R is Cohen-Macaulay, we relate the condition that R is an isolated singularity to finiteness of the dimension of a certain subcategory of $\text{mod } R$. Resolving subcategories of finite radius over a complete intersection are also investigated. (Received February 04, 2012)

1081-13-134 **Sabine El Khoury** and **Hema Srinivasan*** (srinivasanh@missouri.edu), Department of Mathematics, University of Missouri, Columbia, MO 65211. *Bounds for Gorenstein Hilbert Coefficients.*

For graded Gorenstein Algebras with quasi pure resolutions, the multiplicity satisfies a much stronger bounds than the ones for Cohen Macaulay, non Gorenstein algebras. The Multiplicity is the top coefficient of the Hilbert Polynomial,

$$P_S(x) = \sum_{i=0}^{d-1} (-1)^i e_i \binom{x+d-1-i}{x}$$

We extend analogous bounds for the higher coefficients e_i , $i > 0$ of the Hilbert Polynomial. This extends the result of Herzog and Zheng for Coehn Macaulay algebras. (Received February 07, 2012)

1081-13-135 **A. V. Jayanthan** and **Hema Srinivasan*** (srinivasanh@missouri.edu). *Complete Intersection Monomial Curves.*

Let $\mathbf{b} = (b_1, \dots, b_n)$ be an increasing sequence of positive integers and $S_{\mathbf{b}}(a) = k[x^a, x^{a+b_1}, \dots, x^{a+b_n}] \subset k[x]$ be a semigroup ring. We prove that for any \mathbf{b} , complete intersection semigroup rings $S_{\mathbf{b}}(a)$, if they occur for large values of a , do so periodically with period b_n . That is, the set of complete intersections in $S_{\mathbf{b}}(a)$ for any fixed \mathbf{b} are either finite or eventually periodic in a . We give a necessary and sufficient condition for the occurrence of complete intersections for large values of a . This proves the periodicity conjecture of Herzog and Srinivasan for complete intersections. (Received February 07, 2012)

1081-13-136 **Juan C. Migliore*** (migliore.1@nd.edu) and **Uwe Nagel** (uwe.nagel@uky.edu). *Numerical Macaulification.* Preliminary report.

An unpublished example due to Joe Harris from c. 1983 gave two smooth space curves with the same Hilbert function, one arithmetically Cohen-Macaulay (ACM) and the other not. Starting with any homogeneous ideal in any number of variables, we give two constructions, each of which produces an ideal with the Hilbert function of a codim. 2 ACM subscheme. We call such a subscheme "numerically ACM," and call such a construction a "numerical Macaulification" of the original ideal. We study the connections between these two constructions, and show that they produce ideals with the same Hilbert function. Specializing to the case where the original ideals are unmixed, codim. 2, we show that (a) every even liaison class, \mathcal{L} , contains numerically ACM subschemes, (b) the subset, \mathcal{M} , of numerically ACM subschemes in \mathcal{L} has, by itself, a Lazarsfeld-Rao structure, and (c) if we begin with a minimal element of \mathcal{L} and apply either construction, the result is a minimal element of \mathcal{M} . Finally, for curves in \mathbb{P}^3 , the even liaison class of curves with Hartshorne-Rao module concentrated in one degree and having dimension n contains smooth, numerically ACM curves, for all $n \geq 1$. The first (and smallest) such example is that of Harris. (Received February 07, 2012)

1081-13-143 **Timothy B.P. Clark** and **Sonja Mapes*** (smapes1@nd.edu), Mathematics Department, University of Notre Dame, Notre Dame, IN 46556. *Minimal free resolutions of rigid monomial ideals.*

In this talk I will define a class of monomial ideals called "rigid" monomial ideals and discuss in what sense they are a generalization of generic monomial ideals. I will also give a description of how to construct the minimal resolution of a certain class of rigid monomial ideals using poset resolutions and I will discuss how our results should generalize to all rigid monomial ideals. (Received February 08, 2012)

1081-13-158 **Laura Ghezzi**, **Shiro Goto** and **Jooyoun Hong*** (hongj2@southernct.edu), Department of Mathematics, Southern Connecticut State University, 501 Crescent Street, New Haven, CT 06515, and **Wolmer V. Vasconcelos**. *Variation of Hilbert Coefficients.* Preliminary report.

For a Noetherian local ring (R, \mathfrak{m}) , the first two Hilbert coefficients, $e_0(I)$ and $e_1(I)$, of an \mathfrak{m} -primary ideal I are known to code for properties of R and even of their normalizations. We give estimations for these coefficients

when I is enlarged (in the case of $e_1(I)$ in the same integral closure class) for general Noetherian local rings. An important case is

$$e_0(J), e_1(J) \longrightarrow e_0(I), e_1(I), \quad I = (J, x).$$

Clearly the optimal baseline is that of an ideal J generated by a system of parameters, but we will consider very general cases. To describe one of these estimates, let (R, \mathfrak{m}) be a Noetherian local ring of positive dimension, let J be an \mathfrak{m} -primary ideal and let $I = (J, h_1, \dots, h_m)$ be integral over J of reduction number $s = \text{red}_J(I)$. Then we prove that

$$e_1(I) - e_1(J) \leq \lambda(R/(J : I)) \cdot \left[\binom{m+s}{s} - 1 \right] \cdot f_0(J),$$

where $f_0(J)$ is the multiplicity of the special fiber of $\mathcal{R}(J) = \bigoplus_{n \geq 0} J^n t^n$ and $\lambda(\cdot)$ denotes the length. This upper bound of the variation can be applied to link the value of $\text{red}_J(I)$ to other properties of J . (Received February 08, 2012)

1081-13-164 **Anurag K Singh*** (singh@math.utah.edu), Department of Mathematics, University of Utah, Salt Lake City, UT 84112. *Rings of Frobenius operators*. Preliminary report.

Let R be a ring of prime characteristic, and M an R -module. The ring of *Frobenius operators* on M is an R -algebra, that is typically not commutative. We will discuss questions on the finite generation of this algebra in the cases where R is a local ring, and the module M is the injective hull of the residue field.

This is work in progress with Moty Katzman, University of Sheffield, and Karl Schwede, Penn State University. (Received February 09, 2012)

1081-13-179 **Susan Marie Cooper*** (s.cooper@cmich.edu), Department of Mathematics, Central Michigan University, Mt. Pleasant, MI 48859, and **Stephen G. Hartke** (hartke2@math.unl.edu), Department of Mathematics, University of Nebraska-Lincoln, Lincoln, NE 68588. *Bounding the Alpha Invariant for Fat Points*.

An often occurring obstacle to solving many problems in algebraic geometry and commutative algebra is the fact that symbolic and regular powers of an ideal are not in general the same. In order to study the extent to which they differ, experts have studied various containment relationships between the two powers. This approach naturally leads to relationships which are combinatorial in nature. In this talk we will look at some recently formulated conjectures of Harbourne and Huneke which relate symbolic and regular powers of ideals of fat points and the combinatorics behind the resulting implications for bounding the Alpha Invariant. This is joint work with S. G. Hartke. (Received February 09, 2012)

1081-13-187 **Raymond C. Heitmann*** (heitmann@math.utexas.edu), Department of Mathematics, University of Texas, 1 University Station, Austin, TX 78712, and **David A. Jorgensen**. *Are Complete Intersections Complete Intersections?*

A commutative local ring is generally defined to be a complete intersection if its completion is isomorphic to the quotient of a regular local ring by an ideal generated by a regular sequence. It has not previously been determined whether or not such a ring is necessarily itself the quotient of a regular ring by an ideal generated by a regular sequence. In this article, it is shown that if a complete intersection is a one dimensional integral domain, then it is such a quotient. However, an example is produced of a three dimensional complete intersection domain which is not a homomorphic image of a regular local ring, and so the property does not hold in general. (Received February 10, 2012)

1081-13-190 **Isabella Novik** and **Ed Swartz*** (ebs@math.cornell.edu). *Hilbert functions of face rings of pseudomanifolds*.

Stanley's use of Hilbert functions of Artinian quotients of face rings revolutionized the study of f-vectors of simplicial complexes. We will examine problems and recent progress in computing Artinian quotients of face rings of pseudomanifolds. This includes complete characterizations of several new 3-dimensional pseudomanifolds. (Received February 10, 2012)

1081-13-193 **Steven Dale Cutkosky*** (cutkoskys@missouri.edu), Dept. Math., Univ. Missouri, Columbia, MO 65211. *Polynomial and non polynomial behavior of homological functions of powers of ideals*.

Suppose that I is a homogeneous ideal in a polynomial ring R over a field k . We consider the related homological functions $a^i(I^n)$, $\text{reg}_i(I^n)$ and $\text{reg}(I^n)$, and discuss their asymptotic behavior. (Received February 11, 2012)

1081-13-195 **Hal Schenck, Alexandra Seceleanu*** (aseceleanu2@math.unl.edu) and **Javid Validashti**. *A hands-on approach to tensor product surfaces.*

A central problem in geometric modeling is to find the implicit equations for a curve or surface defined by a regular or rational map. For surfaces the two most common situations are when $\mathbb{P}^1 \times \mathbb{P}^1 \rightarrow \mathbb{P}^3$ or $\mathbb{P}^2 \rightarrow \mathbb{P}^3$. The image of regular map $\phi : \mathbb{P}^1 \times \mathbb{P}^1 \rightarrow \mathbb{P}^3$ is called a tensor product surface. We study singularities of tensor product surfaces of bidegree $(2, 1)$ in relation to the syzygies of the bigraded ideal generated by sections corresponding to ϕ . We determine *all* possible numerical types of bigraded minimal free resolutions of such an ideal. (Received February 11, 2012)

1081-13-221 **Sean Sather-Wagstaff*** (sean.sather-wagstaff@ndsu.edu) and **Saeed Nasseh** (saeed.nasseh@ndsu.edu). *A local ring has only finitely many semidualizing modules up to isomorphism.* Preliminary report.

A finitely generated module C over a noetherian ring R is semidualizing if $\text{Hom}_R(C, C) \cong R$ and $\text{Ext}_R^i(C, C) = 0$ for all $i \geq 1$. These modules arise in several contexts, for instance, in the study of divisors, in the study of local ring homomorphisms, and in representation theory. In 1974 Vasconcelos conjectured that a Cohen-Macaulay local ring admits only finitely many semidualizing modules up to isomorphism. We will describe the affirmative solution to this conjecture, for any local ring (not necessarily Cohen-Macaulay). The proof uses a combination of techniques from commutative algebra, rational homotopy theory, and representation theory. (Received February 12, 2012)

1081-13-228 **Jesse Beder*** (beder@math.uiuc.edu). *The Grade Conjecture and Asymptotic Intersection Multiplicity.*

Given a finitely generated module M of finite projective dimension over a local ring A of characteristic p , we discuss the asymptotic intersection multiplicity $\chi_\infty(M, A/\underline{x})$, where $\underline{x} = (x_1, \dots, x_r)$ is a system of parameters for M . We give a necessary and sufficient condition for the existence of a system of parameters such that χ_∞ is positive. We use this to prove several results relating to the Grade Conjecture, which states that $\text{grade } M + \dim M = \dim A$ for any module M of finite projective dimension. (Received February 12, 2012)

1081-13-235 **Luchezar L Avramov** and **Srikanth B Iyengar*** (siyengar2@unl.edu), 203 Avery Hall, Department of Mathematics, University of Nebraska-Lincoln, Lincoln, NE 68588. *The evaluation map in local algebra.* Preliminary report.

Lescot proved that for a singular local ring R , with residue field k , the evaluation map $\text{Ext}_R(k, R) \rightarrow \text{Ext}_R(k, k)$, induced by the canonical surjection $R \rightarrow k$, is zero. I will describe a new proof of this result, based on Tate-Vogel cohomology. The argument is simple and, though not elementary, has the merit of extending to local differential graded algebras. Applications include the computation of Bass series of certain local rings. (Received February 13, 2012)

1081-13-240 **David Eisenbud** and **Daniel Erman***, Department of Mathematics, East Hall, Ann Arbor, MI 48109. *Categorified Duality in Boij-Söderberg Theory.* Preliminary report.

The central idea in Boij-Söderberg Theory is that there is a connection between free resolutions over the polynomial ring and sheaf cohomology on projective space. I'll describe the construction of a duality pairing that clarifies this connection. This is joint work with David Eisenbud. (Received February 13, 2012)

1081-13-249 **Christine Berkesch***, Department of Mathematics, Duke University, Box 90320, Durham, NC 27708, and **Daniel Erman, Manoj Kummini** and **Steven V Sam**. *Surprising shapes of free resolutions.*

We classify the shapes of Betti numbers for modules over a regular local ring and their hypersurface rings. By shape, we mean size "up to scalar multiple," in the spirit of the Boij-Soederberg viewpoint for the graded polynomial ring. Through this work, we show the existence of free resolutions whose Betti numbers behave in surprisingly pathological ways. (Received February 13, 2012)

1081-13-251 **Andrew H Hoefel*** (ahhoefel@mast.queensu.ca), Department of Math & Stats, Jeffery Hall, University Ave., Kingston, Ontario K7L 3N6, Canada. *Powers of edge ideals with linear resolutions.*

Let $I(G)$ be the edge ideal of a simple graph G and let \mathcal{F}_k be the set of simple graphs G for which $I(G)^d$ has a linear resolution for all $d \geq k$. Although Herzog, Hibi and Zheng showed that \mathcal{F}_1 is the set of chordal graphs, combinatorial classifications of \mathcal{F}_k for $k \geq 2$ remain to be found. Nevo's family of claw and four cycle free graphs may be a subset of \mathcal{F}_2 since their second powers have linear resolutions, but it is not known whether the higher powers of these graphs also have linear resolutions. I will be talking about combinatorial techniques for showing

higher powers of edge ideals have linear resolutions in an effort to find subsets of the \mathcal{F}_k . (Received February 13, 2012)

1081-13-262 **Vinh An Pham*** (vapnnc@mail.missouri.edu), Mathematics Department, University of Missouri-Columbia, Columbia, MO 65201, and **Steven Dale Cutkosky**. *Valuation Semi-Groups and Generating Sequences on 2-dimensional Local Rings*.

We will discuss the construction of a generating sequence of valuations on 2-dimensional local rings and some applications. We give a complete classification of the valuation semigroups attained on regular local rings of dimension two, and their relationship with the residue field extension of the valuation ring. This generalizes a classical theorem for the case when the residue field of the ring is algebraically closed. We also give some examples of more complex semigroups attained on normal two dimensional local rings, and give some applications to ramification. (Received February 13, 2012)

1081-13-265 **Andrew R Kustin, Janet Striuli and Adela Vraciu*** (vraciu@math.sc.edu). *Rings that do not admit non-free totally reflexive modules*. Preliminary report.

We discuss certain classes of rings for which there are no non-free totally reflexive modules. (Received February 13, 2012)

1081-13-272 **Ian M Aberbach*** (aberbachi@missouri.edu), Department of Mathematics, University of Missouri, Columbia, MO 65211. *Bounding the Hilbert-Kunz multiplicity of nonregular local rings away from one*. Preliminary report.

A conjecture of Watanabe-Yoshida gives lower bounds in each dimension for the smallest possible Hilbert-Kunz multiplicity of an unmixed non-regular local ring. We will look at combining results of Aberbach-Enescu and Celikbas-Dao-Huneke-Zhang to explore what can be said in dimension seven (and, possibly, eight). (Received February 13, 2012)

1081-13-281 **Giulio Caviglia*** (gcavigli@math.purdue.edu) and **Aldo Conca** (conca@dim.unige.it). *Koszul property of projections of the Veronese cubic surface*.

Let $V \subset \mathbf{P}^9$ be the Veronese cubic surface. We classify the projections of V to \mathbf{P}^8 whose coordinate rings are Koszul. In particular we obtain a purely theoretical proof of the Koszulness of the pinched Veronese, a result obtained originally by Caviglia using filtrations, deformations and computer assisted computations. To this purpose we extend, to certain complete intersections, results of Conca, Herzog, Trung and Valla concerning homological properties of diagonal algebras. (Received February 13, 2012)

1081-13-284 **Luis Núñez-Betancourt** and **Emily E. Witt*** (ewitt@umn.edu). *Generalized Lyubeznik Numbers*.

Huneke, Sharp, and Lyubeznik showed that if S is a regular local ring of equal characteristic, the Bass numbers of all local cohomology modules of the form $H_i^j(S)$ are finite. Using this fact, Lyubeznik was able to define certain invariants of equal characteristic local rings, now called *Lyubeznik numbers*. We generalize this definition, give examples of these *generalized Lyubeznik numbers*, and investigate their properties. (Received February 13, 2012)

1081-13-285 **Gemma Colomé-Nin*** (gcolomen@math.purdue.edu), Purdue University, Department of Mathematics, 150N. University Street, West Lafayette, IN 47907, and **Juan Elias**. *Asymptotic depth of non-standard multigraded modules*.

The aim of the talk is to present some results, using different approaches, on the study of the asymptotic stability of the depth of the homogeneous components of a multigraded module over a non-standard multigraded algebra. We also study the asymptotic behavior of the set of associated primes of these components. If time permits, we will apply the results to the study of the depth of powers of a finite set of ideals. (Received February 13, 2012)

1081-13-305 **Uwe Nagel*** (uwe.nagel@uky.edu), Department of Mathematics, University of Kentucky, 715 Patterson Office Tower, Lexington, KY 40506, and **Stephen Sturgeon** (stephen.sturgeon@uky.edu), Department of Mathematics, University of Kentucky, 715 Patterson Office Tower, Lexington, KY 40506. *Combinatorial Interpretations of some Boij-Söderberg Decompositions*. Preliminary report.

Boij-Söderberg theory shows that the Betti table of any graded module can be uniquely written as a linear combination of pure diagrams where the coefficients are positive rational numbers. Using Ferrers hypergraphs, we provide an interpretation of the coefficients in some cases. (Received February 13, 2012)

1081-13-307 **Melvin Hochster** and **Yongwei Yao*** (yyao@gsu.edu). *Test exponents for modules with finite phantom projective dimension.*

Let (R, \mathfrak{m}) be an equidimensional excellent local ring of prime characteristic $p > 0$. We give an alternate proof of the existence of a uniform test exponent for any given $c \in R^\circ$ and all ideals generated by (full or partial) systems of parameters. This follows from a more general result about the existence of a test exponent for any given Artinian R -module. If we further assume R is Cohen-Macaulay, then there exists a test exponent for any given $c \in R^\circ$ and all perfect modules. This is joint work with Mel Hochster. (Received February 13, 2012)

1081-13-319 **Florian Enescu*** (fenescu@gsu.edu), Department of Mathematics and Statistics, Georgia State University, Atlanta, GA 30303. *Local cohomology and FH-finite rings.* Preliminary report.

In this talk, we will discuss the local cohomology modules with support in the maximal ideal of a local ring of positive characteristic and the class of FH-finite rings. This class is characterized by a finiteness condition on the local cohomology which is related to the Frobenius homomorphism. Sufficient conditions on the ring that imply the FH-finite property will be presented. (Received February 13, 2012)

1081-13-323 **Kevin Tucker*** (kftucker@math.princeton.edu). *Test Ideals in F -Regular Rings.*

The test ideal is an important measure of singularities in positive characteristic commutative algebra and algebraic geometry. In this talk, I will provide an answer to a question of Mustařa and Yoshida concerning which ideals in an F -regular ring can be realized as test ideals. (Received February 13, 2012)

1081-13-328 **C-Y. Jean Chan*** (chan1cj@cmich.edu), Department of Mathematics, PE 214, Central Michigan University, Mt. Pleasant, MI 48859, and **Kazuhiko Kurano** (kurano@isc.meiji.ac.jp), Meiji University, Japan. *An application of relational equivalence to Hilbert-Kunz Functions.*

We know that divisor class groups are defined for normal rings. When a ring under consideration is not normal, the Chow group can be utilized in place of the divisor class group in some cases. Inspired by the work of Huneke, McDermott and Monsky (Math. Res. Lett. 11 (2004) 539–546) that proves the existence of the second highest coefficient of the Hilbert-Kunz function of a module over a normal local ring, we will discuss how the rational equivalence contributes to proving the stability of the Hilbert-Kunz functions in a more general setting than normal domains. We also estimate an *additive error* of the Hilbert-Kunz functions on a short exact sequence of finitely generated modules. This is a joint work with Kazuhiko Kurano. (Received February 13, 2012)

1081-13-334 **Ananthnarayan Hariharan***, ahariharan2@math.unl.edu, and **Ela Celikbas** and **Zheng Yang**. *Decomposing Gorenstein Rings as a Connected Sum.* Preliminary report.

We will recall the definition of a connected sum of Gorenstein local rings. We will then explore some conditions under which a given Gorenstein ring can be written as a connected sum. (Received February 14, 2012)

1081-13-342 **Karl Schwede** and **Wenliang Zhang***, Department of Mathematics, University of Michigan, 530 Church Street, Ann Arbor, MI 48109. *Bertini theorems for F -singularities.*

I will discuss Bertini-type theorems for strongly F -regular and F -pure singularities (including in the context of pairs) by building upon a framework of Cumino, Greco and Manaresi (compare with the work of Jouanolou and Spreafico). If time permits, I will also explain that F -injective singularities fail to satisfy even the most basic Bertini-type results. This is a joint work with Karl Schwede. (Received February 14, 2012)

1081-13-347 **Melissa Lindsey*** (melissa.lindsey@indwes.edu). *Maximizing the global Betti numbers of lex-plus-powers ideals.*

We investigate the global Betti numbers of homogeneous ideals in a polynomial ring that contain a monomial complete intersection. Given a fixed monomial complete intersection in a polynomial ring we determine the maximum first and last Betti numbers for homogeneous ideal that contain the complete intersection. In the case of a polynomial ring in three variables we also determine the maximum second Betti number. We make use of the result of Mermin-Murai that proves the Lex Plus Powers conjecture for ideals containing a monomial regular sequence to restrict to Lex Plus Powers Ideals. (Received February 14, 2012)

1081-13-352 **Liana M Segal*** (segal@umkc.edu). *Characterizations of quasi-complete intersection ideals.*

Quasi-complete intersection ideals have been recently studied in a paper of Avramov, Henriques and Segal. The definition of this concept is in terms properties of Koszul homology, and a more ideal theoretic understanding is only available for principal ideals. I will discuss some concrete characterizations of quasi-complete intersection ideals, under various restrictions on the ring. (Received February 14, 2012)

1081-13-356 **Claudia Miller** and **Janet Striuli***, North Benson Road, Fairfield, CT 06824, and **Hamidreza Rahmati**. *A Duality Theorem for ideals of a Gorenstein ring.*

In this talk we present a duality theorem for Koszul homology modules. The result applies to all ideals in a Gorenstein ring, extending Poincaré duality. We also give some related results on strongly Cohen-Macaulay ideals. This is joint work with Claudia Miller and Hamid Rahmati. (Received February 14, 2012)

1081-13-357 **Jennifer Biermann*** (jvbierma@lakeheadu.ca) and **Adam Van Tuyl**. *Balanced vertex decomposable simplicial complexes and their h -vectors.*

Given any finite simplicial complex Δ , I will discuss how to construct a new simplicial complex Δ_χ that is balanced and vertex decomposable and whose h -vector is the f -vector of the original complex. This construction generalizes the “whiskering” construction of Villarreal, and Cook and Nagel. I will also discuss how to reverse this process in the special case of the independence complex of a chordal graph. (Received February 14, 2012)

1081-13-374 **Ben Richert*** (brichert@calpoly.edu), Math Dept, Cal Poly, San Luis Obispo, CA 93407. *Partitionable Simplicial Complexes*. Preliminary report.

A simplicial complex Δ is said to be partitionable if there exists a partition $\Delta = \cup_{i=1}^r [F_i, G_i]$ where the G_i are the facets of Δ and $[F_i, G_i] = \{F \in \Delta \mid F_i \subseteq F \subseteq G_i\}$. Stanley has conjectured that if Δ is Cohen-Macaulay then Δ is partitionable. We assume this conjecture and explore some of the implications.

If Δ is a pure simplicial complex of dimension n on v vertices, we define $C_{(n-1)}(\Delta)$ to be the simplicial complex on one more vertex $v+1$ such that $\{i_1, \dots, i_k\} \in C_{(n-1)}(\Delta)$ if and only if either $\{i_1, \dots, i_k\} \in \Delta$ or $i_k = v+1$, $\{i_1, \dots, i_{k-1}\} \in \Delta$ and $k-1 \leq n-1$. Let $C_{n-1}^t(\Delta)$ be the t -fold application of this procedure. Then we prove that $\min\{t \mid C_{n-1}^t(\Delta) \text{ is partitionable}\} = \dim(k[\Delta]) - \text{depth}(k[\Delta])$ where $k[\Delta]$ is the Stanley-Reisner ring of Δ . (Received February 14, 2012)

1081-13-381 **Claudia Miller*** (clamille@syr.edu), **Hamid Rahmati** and **Janet Striuli**. *Duality for Koszul Homology over Gorenstein Rings.*

When a ring is Gorenstein, certain modules over it often exhibit nice duality properties. One such classic duality, due to Herzog, holds for the Koszul homologies of an ideal if they are Cohen-Macaulay. We give that a slightly weaker version that holds for any ideal in a Gorenstein ring; this was proved in the graded case by Chardin via a different spectral sequence. In a different direction, we give a set of results in which duality forces Cohen-Macaulayness if a certain amount of local depth is present. The second a weakened sliding depth condition and yields an extension of a result of Herzog, Vasconcelos, and Villarreal. This is joint work with Hamid Rahmati and Janet Striuli. (Received February 14, 2012)

1081-13-384 **Daniel J Hernández*** (dhernan@umn.edu). *F -purity of binomial hypersurfaces.*

The F -pure threshold is an invariant of singularities defined via the Frobenius morphism in positive characteristic. In this talk, we will discuss an algorithm for computing the F -pure threshold of an arbitrary binomial hypersurface. (Received February 14, 2012)

1081-13-386 **Louiza Fouli*** (lfouli@math.nmsu.edu), Department of Mathematical Sciences, New Mexico State University, Las Cruces, NM 88003, and **Kuei-Nuan Lin**, Department of Mathematics, University of California, Riverside, Riverside, CA 92521. *Square-free monomial ideals of linear type*. Preliminary report.

In the 60s Micali showed that complete intersection ideals are of linear type. Later on several authors determined more classes of ideals that are of linear type. We consider a construction that allows us to establish the defining equations of the Rees algebra for certain square-free monomial ideals generated in the same degree. This has lead us to discover new classes of square-free monomial ideals that are of linear type. (Received February 14, 2012)

1081-13-396 **Michael Von Korff*** (vonkorff@umich.edu). *The F -Signature of an Affine Toric Variety.*

The Frobenius map on a ring of positive characteristic may be used to construct various useful numerical invariants. The F -signature is one such invariant. It measures the asymptotic growth of the number of splittings of iterates of the Frobenius map and encodes geometric and algebraic properties of the ring. In this talk, I will compute the F -signature of a monomial ring (equivalently, of the coordinate ring of an affine toric variety). This computation generalizes a previous computation of Watanabe and Yoshida. The F -signature of pairs and triples is a related notion recently defined by Blickle, Schwede, and Tucker. I will also indicate how to compute the F -signature of pairs and triples of a monomial ring. (Received February 14, 2012)

1081-13-397 **Lars Winther Christensen*** (lars.w.christensen@ttu.edu). *Local rings of trivial \mathcal{G} -type and compactly generated categories*. Preliminary report.

If a Gorenstein Artin algebra has finite \mathcal{G} -type—that is, A has up to isomorphism only finitely many indecomposable totally reflexive modules—then every Gorenstein projective A -module is a direct sum of totally reflexive A -modules. This theorem, obtained by Xiao-Wu Chen in 2008, is akin to a classic result in representation theory: every module over an Artin algebra of finite representation type is a direct sum of finitely generated modules. The natural question, whether the Gorenstein hypothesis is superfluous in Chen’s theorem, is non-trivial even in the commutative setting; I will report on recent progress towards an answer. (Received February 14, 2012)

14 ► Algebraic geometry

1081-14-3 **Alina Marian*** (a.marian@neu.edu). *Strange duality for K3 and abelian surfaces*.

My focus will be a conjectural duality, first proposed by J. Le Potier, relating spaces of sections of determinant line bundles over two complementary moduli spaces of sheaves on a fixed projective surface. I will describe progress, in joint work with D. Oprea, toward proving the conjecture for K3 and abelian surfaces. (Received February 13, 2012)

1081-14-5 **Alan Veliz-Cuba*** (aveliz-cuba2@unl.edu), aveliz-cuba2@unl.edu. *An algebraic geometry approach to the reverse-engineering problem*.

When certain regulation mechanisms of a biological system or a model are unknown it is important to identify the best model with the available data. In this context, reverse engineering a system from partial information is an important problem. In this talk we will present a framework and algorithms to reverse engineer the possible interactions of a system from data. The algorithm consists in encoding all possible interactions using ideals and algebraic sets, and choose those that are minimal using the primary decomposition and the irreducible components. (Received October 19, 2011)

1081-14-84 **Qi Zhang*** (zhanqi@missouri.edu), Department of Mathematics, University of Missouri, Columbia, MO 65203, and **M Chen**. *On a question of Demailly-Peternell-Schneider*.

In this talk, we shall present an affirmative answer to an open question posed by Demailly-Peternell-Schneider in 2001. Let $f: X \rightarrow Y$ be a surjective morphism from a log canonical pair (X, D) onto a \mathbb{Q} -Gorenstein variety Y . If $-(K_X + D)$ is nef, we show that $-K_Y$ is pseudo-effective. This is a joint work with Meng Chen. (Received January 31, 2012)

1081-14-86 **Zhenbo Qin*** (qinz@missouri.edu), Department of Mathematics, University of Missouri, Columbia, MO 65211. *The Cohomological Crepant Resolution Conjecture for the Hilbert-Chow morphisms*.

In a recent joint work with Wei-Ping Li, we proved that Ruan’s Cohomological Crepant Resolution Conjecture holds for the Hilbert-Chow morphisms. We will outline the two main ideas used in the proof. This talk is independent of, but related to the talk “Cohomology rings of Hilbert schemes of points on surfaces” given by the same speaker in the special session on “Geometry of Moduli Spaces of Sheaves”. (Received February 01, 2012)

1081-14-87 **Zhenbo Qin*** (qinz@missouri.edu), Department of Mathematics, University of Missouri, Columbia, MO 65211. *Cohomology rings of Hilbert schemes of points on surfaces*.

The Hilbert schemes of points may be regarded as moduli spaces of rank-1 torsion free sheaves. We will survey the ordinary cohomology ring and quantum corrected cohomology ring of the Hilbert schemes of points on surfaces, leading to the proof of Ruan’s Cohomological Crepant Resolution Conjecture. This talk is independent of, but related to the talk “The Cohomological Crepant Resolution Conjecture for the Hilbert-Chow morphisms” given by the same speaker in the special session on “Algebraic Geometry and its Applications”. (Received February 01, 2012)

1081-14-93 **Adrian Clingher*** (clinghera@ums1.edu), Department of Mathematics, University of Missouri - St. Louis, One University Blvd., St. Louis, MO 63121. *K3 Surfaces of High Picard Rank*.

I will report on a classification of a certain class of K3 surfaces of Picard rank 16 or higher. In terms of periods, the moduli space of these objects is a quotient of a four-dimensional bounded symmetric domain of type IV. Explicit normal forms will be presented, as well as a discussion of modular forms associated with this family. (Received February 02, 2012)

1081-14-94 **Thomas Nevins*** (nevins@illinois.edu), Department of Mathematics, University of Illinois at Urbana-Champaign, 1409 W. Green Street, MC-382, Urbana, IL 61801. *Derived equivalences for quantum symplectic resolutions.*

Quantizations of symplectic resolutions appear in many aspects of geometric representation theory related to enveloping algebras of semisimple Lie algebras, rational Cherednik algebras, and other examples. I will discuss a framework for proving derived equivalences for quantum symplectic resolutions in characteristic zero that formalizes ideas of Bridgeland and Bezrukavnikov-Mirkovic-Rumynin. I will then explain how it applies to the examples mentioned. Finally, provided there is ample remaining time, I may say something about how t -structures should behave under such equivalences. This is joint work with K. McGerty of Oxford. (Received February 02, 2012)

1081-14-109 **Nicolo Sibilla***, sibilla@math.northwestern.edu. *Mirror Symmetry and Ribbon Graphs.*

In this talk, I will explain a conjectural description of the Fukaya category of a punctured Riemann surface in terms of a sheaf of dg categories over its skeleton. This is based on recent ideas of Kontsevich, and is joint with D. Treumann and E. Zaslow. I will discuss applications to mirror symmetry for degenerate elliptic curves, and generalizations to higher dimensions. Further, time allowing, I'll talk about the way in which this framework gives interesting algebro-geometric information on degenerate elliptic curves, and describe work of myself on mapping class group actions on their derived categories. (Received February 03, 2012)

1081-14-110 **Mihai Fulger*** (mfulger@umich.edu). *Local volumes.*

We develop a theory of local volumes for Cartier divisors on blow-ups of a normal variety of dimension n at least two, with a distinguished point. We use this to extend to arbitrary dimension results of Wahl concerning volumes of isolated surface singularities. We also compare our generalization of Wahl's work to a different one due to Boucksom, de Fernex, and Favre. (Received February 04, 2012)

1081-14-114 **Mathias Schulze*** (mschulze@math.okstate.edu), Oklahoma State University, Department of Mathematics, Stillwater, OK 74078. *An algebraic extension of the Lê-Saito Theorem.*

Lê and K. Saito showed that a complex hypersurface is normal crossing in codimension 1 if and only if the local fundamental groups of the complement are abelian. Answering a question of Saito, we show that the latter property can be characterized purely algebraically in terms of logarithmic residues. To this end, we introduce a dual version of Saito's logarithmic residue map. The talk is based on joint work with Michel Granger. (Received February 04, 2012)

1081-14-118 **Nero Budur*** (nbudur@nd.edu), University of Notre Dame, Department of Mathematics, 255 Hurley Hall, Notre Dame, IN 46556. *Multi-variable topological zeta functions.* Preliminary report.

The Monodromy Conjecture relates the poles of the topological zeta function of a polynomial with the Milnor monodromy eigenvalues and with the Bernstein-Sato polynomial. We prove a generalization to the multi-variable setting of the Monodromy Conjecture for hyperplane arrangements. We state a stronger conjecture relating Alexander invariants with Bernstein-Sato ideals and address it in some particular cases. (Received February 05, 2012)

1081-14-122 **Yan Soibelman*** (soibelm@math.ksu.edu), Department of Mathematics, KSU, Manhattan, KS 66506. *Wall-crossing formulas, Mirror Symmetry and integrable systems.* Preliminary report.

Talk is devoted to the interplay between SYZ picture of Mirror Symmetry, theory of Donaldson-Thomas invariants developed jointly by Maxim Kontsevich and the speaker, and complex integrable systems of Hitchin type. Unifying mathematical structure is called "wall-crossing data". It underlies the cluster variety structure on the moduli space of local systems, resurgence properties of WKB solutions of Schrödinger equation and count of geodesics of quadratic differentials on Riemann surfaces. (Received February 06, 2012)

1081-14-124 **Ilya Zharkov*** (zharkov@math.ksu.edu), 138 Cardwell Hall, Mathematics Department, Manhattan, KS 66506. *Tropical Prym Varieties and Conic Bundles.* Preliminary report.

I will describe the tropical analogue of the classical construction of an Abelian variety (called Prym) associated to a double cover of a curve. In particular, I will consider an example of the discriminant plane quintics arising from cubic threefold considered as conic bundle. This way I recover one of the most famous classical non-rationality statements of Griffiths and Clemens. (Received February 06, 2012)

1081-14-129 **Laurentiu Maxim*** (maxim@math.wisc.edu), Department of Mathematics, 480 Lincoln Drive, Van Vleck Hall, Madison, WI 53706. *Characteristic classes of Hilbert schemes of points via symmetric products*. Preliminary report.

I will explain a formula for the generating series of (the push-forward under the Hilbert-Chow morphism of) homology characteristic classes of the Hilbert schemes of points for a smooth quasi-projective variety of arbitrary pure dimension. The result is based on a geometric construction of a motivic exponentiation generalizing the notion of motivic power structure, as well as a formula for the generating series of homology characteristic classes of symmetric products. This is joint work with Cappell, Ohmoto, Schuermann and Yokura. (Received February 06, 2012)

1081-14-141 **Arend Bayer*** (arend.bayer@uconn.edu) and **Emanuele Macrì**. *Projectivity and birational geometry of Bridgeland moduli spaces*.

I will present a construction of a nef divisor for every moduli space of Bridgeland stable complexes on an algebraic variety. In the case of K3 surfaces, we can use it to prove projectivity of the moduli space, generalizing a result of Minamide, Yanagida and Yoshioka. Its dependence on the stability condition gives a systematic explanation for the compatibility of wall-crossing of the moduli space with its birational transformations; this had first been observed in examples by Arcara-Bertram. (Received February 07, 2012)

1081-14-155 **Botong Wang*** (wang191@math.purdue.edu). *Filtered local systems and parabolic Higgs bundles*.

Moduli space of (parabolic) Higgs bundles over (noncompact) Riemann surfaces are well studied in the past twenty years. Based on Mochizuki's work on Hichin-Kobayashi correspondence for quasi-projective varieties, we study the moduli space of stable parabolic Higgs bundles for higher dimensional varieties. Similar to the curve case, we prove some isomonodromy loci of the moduli have natural Hyperkähler structures.

Toward finding examples of parabolic Higgs bundles, we give some necessary conditions of stable parabolic Higgs bundles of trivial characteristic numbers. This is done using some perturbation method. And applying the same method to the filtered local systems, I will reprove some properties of the fundamental groups of quasi-projective varieties due to M. Nori. (Received February 08, 2012)

1081-14-162 **Alexander Yong*** (ayong@uiuc.edu), Mathematics Department, UIUC, 1409 W. Green Street, Urbana, IL 61801. *Varieties in flag manifolds and their patch ideals*.

I will discuss analysis of singularities of varieties X that naturally sit inside a flag manifold G/P . The main examples of the talk are Schubert varieties, Richardson varieties and Peterson varieties. The common method utilized is the construction of explicit local coordinates and equations, the "patch ideals". I will illustrate results using these ideas from work with Erik Insko (U. Iowa), Li Li (Oakland University) and Alexander Woo (U. Idaho). (Received February 09, 2012)

1081-14-163 **Emanuele Macrì*** (macri.6@osu.edu), The Ohio State University, Department of Mathematics, 231 W 18th Avenue, Columbus, OH 43210. *ACM bundles on cubics*.

We use Kuznetsov's description of the derived category of a smooth cubic hypersurface to give a new construction of some stable ACM bundles on cubic threefolds and fourfolds, via Fourier-Mukai techniques. If time permits, we will also discuss applications to deformations of K3 categories.

This is a joint work with Marti' Lahoz and Paolo Stellari. (Received February 09, 2012)

1081-14-167 **Ravindra Girivaru*** (girivarur@ums1.edu), 354, ESH, Department of Math and CS, 1 University Boulevard, University of Missouri, St. Louis, MO 63105. *Extension theorems for cycles and bundles*. Preliminary report.

Let Y be a smooth, projective variety and X a smooth, ample hyperplane section in Y . Given a subvariety $Z \subset X$ (respectively a bundle E on X), under what conditions can one find a subvariety $Z' \subset Y$ (respectively a bundle E' on Y) such that $Z = Z' \cap X$ (respectively $E = E'|_X$).

When the subvariety is of codimension 1 (respectively the bundle has rank 1), these are answered by the Lefschetz theorems. I will talk about generalisations of these theorems. (Received February 09, 2012)

1081-14-194 **Steven Dale Cutkosky*** (cutkoskys@missouri.edu), Dept. Math., Univ. Missouri, Columbia, MO 65211. *The Stellar Vault*.

We consider Hironaka's concept of La Voute Étoilée (The Stellar Vault) in the study of germs of complex analytic spaces. An étoile is the analogue of a valuation in algebraic geometry. An étoile on X picks out a unique point on any local blow up of X .

We discuss some of the interesting properties of an étoile, and prove a local monomialization theorem for a germ of a morphism of complex analytic spaces $\phi : X \rightarrow Y$, with the condition that $\dim \phi(X) = \dim X$ (dimension means “complex dimension”). (Received February 11, 2012)

1081-14-199 **Bhargav Bhatt***, University of Michigan, Department of Mathematics, Ann Arbor, MI 48109. *Moduli of products.*

We will discuss the relation between the moduli space of a product of varieties, and the product of the moduli spaces of the factors. For (stable) curves, Van Opstall showed that taking products gives an isomorphism between these two spaces, up to controlled finite étale covers. We will explain why the same picture exists in all dimensions provided we replace (stable) curves with (stable) varieties, as defined by the minimal model program. This is joint work with Wei Ho, Zsolt Patakfalvi, and Christian Schnell. (Received February 11, 2012)

1081-14-206 **Stefan O Tohaneanu*** (stohanea@uwo.ca), Department of Mathematics, The University of Western Ontario, London, Ontario N6A 5B7, Canada. *The variety of codewords of minimum weight.* Preliminary report.

The set of (projective) codewords of minimum weight of any linear code can be viewed as a zero-dimensional projective variety of defining ideal I . It turns out that I is the saturation of a simpler ideal J , which is generated by products of linear forms. With this in mind we obtain characterizations of classical notions in coding theory using algebraic geometry: a linear code is MDS iff $I = J$; or the number of (projective) codewords of minimum weight equals the Hilbert polynomial of R/J . The projective codewords of minimum weight have a nice geometric interpretation related to “the fitting problem”. I will discuss about this as well, and about three computational methods (coming from algebraic geometry) to find these particular codewords. (Received February 11, 2012)

1081-14-216 **Gordon Heier*** (heier@math.uh.edu) and **Shigeharu Takayama.** *On uniformly effective birationality and the Shafarevich Conjecture over curves.*

We will discuss the following recent effective boundedness result for the Shafarevich Conjecture over function fields. Let B be a smooth projective curve of genus g , and $S \subset B$ be a finite subset of cardinality s . There exists an effective upper bound on the number of deformation types of admissible families of canonically polarized manifolds of dimension n with canonical volume v over B with prescribed degeneracy locus S . The effective bound only depends on the invariants g, s, n and v . The key new ingredient which allows for this kind of result is a careful study of effective birationality for families of canonically polarized manifolds. This is joint work with S. Takayama. (Received February 12, 2012)

1081-14-218 **Elizabeth A. Sell***, Department of Mathematics, Millersville University, P.O. Box 1002, Millersville, PA 17551. *Splice quotients of the form $z^n = f(x, y)$.*

The splice quotients are an interesting class of normal surface singularities with rational homology sphere links. In general, it is difficult to determine whether or not a singularity is analytically isomorphic to a splice quotient, although there are certain necessary topological conditions. We discuss results concerning singularities defined by an equation of the form $z^n = f(x, y)$, where f is irreducible. In particular, we completely characterize, in terms of n and a variant of the Puiseux pairs of f , those which satisfy the topological conditions that are necessary for splice quotients. Furthermore, we show that if these topological conditions are satisfied, then there exists a splice quotient defined by an equation of the form $z^n = g(x, y)$, where the plane curve singularity defined by $g = 0$ has the same topological type as the one defined by $f = 0$. (Received February 12, 2012)

1081-14-227 **Chih-Chi Chou*** (cchou20@uic.edu), 851 S Morgan street, 320 SEO, Chicago, IL 60607. *A Transversality theorem for some Classical Varieties.*

In 2009, de Fernex and Hacon proposed a generalization of the notion of the singularities to normal varieties that are not \mathbb{Q} -Gorenstein. Based on their work, we generalize Kleiman’s transversality theorem to subvarieties with log terminal or log canonical singularities. We also show that some classical varieties, such as generic determinantal varieties, W_d^r for general smooth curves are log terminal. (Received February 12, 2012)

1081-14-231 **A.P. Rao***, Dept of Mathematics, University of Missouri-St. Louis, Saint Louis, MO 63121. *ACM rank two bundles on quintic threefolds.*

A general quintic threefold admits only finitely many ACM bundles of rank two, of 14 different types according to Chiantini-Madonna. We describe the classification and also various cases where the enumeration of these bundles is possible. (Received February 12, 2012)

1081-14-236 **Brian Harbourne*** (bharbour@math.unl.edu), Mathematics Department, University of Nebraska, Lincoln, NE 68588-0130. *Symbolic powers of ideals of lines in projective space and a conjecture of Nagata type.*

We define asymptotic versions of the resurgence which we use to study which symbolic powers of ideals of lines in projective space are contained in a given power of the ideal. This raises a question related to a famous conjecture of Nagata as to the least degree of a form vanishing to given order on a set of lines (Nagata's conjecture concerns the same issue but for points). This is joint work with Elena Guardo and Adam Van Tuyl. (Received February 13, 2012)

1081-14-238 **Brian Harbourne*** (bharbour@math.unl.edu), Mathematics Department, University of Nebraska, Lincoln, NE 68588-0130. *Results on ideals of star configurations in projective space.*

We leverage results about monomial ideals to determine properties of symbolic powers of ideals of star configurations (star configurations are certain unions of linear subspaces of projective space whose ideals share a lot of properties with monomial ideals). Questions we study are: which such ideals define subschemes which are arithmetically Cohen-Macaulay, and what are the primary decompositions of powers of ideals of star configurations? This is joint work with A. V. Geramita and J. Migliore. (Received February 13, 2012)

1081-14-239 **Brian Harbourne*** (bharbour@math.unl.edu), Mathematics Department, University of Nebraska, Lincoln, NE 68588-0130. *Splitting of the pullback of the cotangent bundle on rational curves.*

Given a morphism of the projective line into the projective plane that is birational to its image, a problem that has seen recent attention lately in geometric modeling is to determine the splitting of the pullback of the cotangent bundle. Results of M. G. Ascenzi (periodically rediscovered but rarely improved upon) determine the splitting when the image curve has a singularity of fairly large multiplicity. We study what happens when the splitting is not forced by Ascenzi's results, in the situation in which the singularities of the image curve are situated generically. For image curves with at most 9 singular points we pose a conjectural answer to the problem. This is joint work with A. Gimigliano and M. Ida. (Received February 13, 2012)

1081-14-242 **Stefano Urbinati*** (urbinati@math.utah.edu), MATH DEPARTMENT: 155 S 1400 E ROOM 128, Salt Lake City, UT 84112. *Divisorial models of non- \mathbb{Q} -Gorenstein varieties.*

Based on the construction of de Fernex and Hacon, we study the behavior of the singularities on non- \mathbb{Q} -Gorenstein varieties, in particular for which the canonical ring is not a finitely generated \mathcal{O}_X -algebra. We will focus on some pathologies arising naturally from the construction and in particular we will give an example of an irrational jumping number. On the other side, we prove that there are no accumulation points for the jumping numbers of normal non- \mathbb{Q} -Gorenstein varieties with isolated singularities. We also prove that Canonical singularities in this new setting are equivalent to the finite generation of the canonical ring. Finally, we introduce a notion of nefness that doesn't require intersection theory, with studying the behavior of the new feature. (Received February 13, 2012)

1081-14-247 **Ragnar-Olaf Buchweitz, Graham J Leuschke*** (gjleusch@math.syr.edu) and **Michel Van den Bergh.** *Non-commutative desingularization of determinantal varieties.*

We construct non-commutative resolutions of determinantal varieties defined by arbitrary-size minors of a generic matrix. The resolution can be presented as the path algebra of a quiver with relations, where the underlying graph of the quiver is an ideal in the Young lattice of partitions. (Received February 13, 2012)

1081-14-250 **Vivek Shende*** (vivek@math.mit.edu). *Plane curve singularities, Hilbert schemes, HOMFLY homology, and Cherednik algebras.*

I will discuss a conjecture identifying the cohomology of certain nested Hilbert schemes of points on a plane curve singularity with the HOMFLY homology of the link of that singularity. The conjecture may be restated in terms of the cohomology of parabolic Hitchin fibers, in which form, and when restricted to toric singularities, it suggests the existence of the action of a rational Cherednik algebra on the HOMFLY homology of torus knots. As a consequence, the conjectures predict that the homology of $(n, n+1)$ torus knots is described by formulas familiar from Haiman's study of diagonal harmonics, and the $(n, mn+1)$ torus knots by known generalizations of these. (Received February 13, 2012)

1081-14-261 **Claudiu Raicu*** (craicu@math.princeton.edu), Department of Mathematics, Fine Hall, Washington Road, Princeton, NJ 08544-1000. *Syzygies of Segre-Veronese varieties and the homology of clique complexes.*

I will explain how the syzygies of projective embeddings of products of projective spaces (also known as Segre-Veronese varieties) can be determined by understanding the homology of the clique complexes associated to certain families of graphs. This leads in particular to a combinatorial derivation of the minimal free resolutions of the ideals of 2-minors of generic matrices and generic symmetric matrices, which have been previously computed using geometric methods by Lascoux, Pragacz and Weyman. (Received February 13, 2012)

1081-14-275 **Daniel Murfet***, 415 Gayley av. apt 112, Los Angeles, CA 90024. *Computing Khovanov-Rozansky homology.*

In 2004 Khovanov and Rozansky introduced a homological invariant of links defined using matrix factorisations. While the definition is elementary, computations are hard, and I will explain joint work with Nils Carqueville in which we produced many new examples using a combination of a novel theoretical tool for computing cohomology via splitting idempotents, together with more hours of computer time than we care to recall. (Received February 13, 2012)

1081-14-283 **Daniel Schultheis*** (dschulth@math.ucsd.edu). *Virtual invariants on Quot schemes over toric surfaces.* Preliminary report.

Let C be a smooth projective curve and consider $\text{Quot}_C(\mathbb{G}(r, N), d)$, the Quot scheme of degree d , rank $N - r$ quotients of \mathcal{O}_C^N . Numerous mathematicians have studied the intersection theory of $\text{Quot}_C(\mathbb{G}(r, N), d)$, culminating in a proof that the virtual count of maps from C to the Grassmannian $\mathbb{G}(r, N)$ satisfies the well known Vafa-Intriligator formula. We will explore the history of this problem and focus on recent generalizations when C is replaced by a toric surface. (Received February 13, 2012)

1081-14-298 **Adam J Ginensky*** (adam.ginensky@yahoo.com). *Determinantal Equations for Secant Varieties.* Preliminary report.

Abstract. We show that if a smooth variety X is re-embedded by a sufficiently large Veronese embedding then, set theoretically, the equations of the r -th secant variety of X are just the equations defining the r -th secant variety of the Veronese embedding of original projective space and the obvious linear equations. This reduces the question of finding the equations of the secant variety of a (sufficiently amply embedded) variety to the finding of the equations of the secant variety of a Veronese embedding of a projective space. Time permitting, context and other results will be mentioned. This is joint work with J. Buczynski and J.M. Landsberg (Received February 13, 2012)

1081-14-301 **Jason Lo*** (locc@missouri.edu), Mathematics Department, 202 Mathematical Sciences Building, University of Missouri, Columbia, MO 65211. *Stable complexes and Fourier-Mukai transforms.* Preliminary report.

Given a Fourier-Mukai transform between the derived categories of two varieties, one natural question is, does it take stable sheaves to stable sheaves? After the recent constructions of moduli of stable complexes, we can also ask, does the Fourier-Mukai transform take stable complexes to stable sheaves? Building on the work of Bridgeland's and Maciocia's, I will consider the latter question for elliptic fibrations. (Received February 13, 2012)

1081-14-303 **Jason Lo*** (locc@missouri.edu), Mathematics Department, 202 Mathematical Sciences Building, University of Missouri, Columbia, MO 65211, and **Ziyu Zhang** (zhangzy@mpim-bonn.mpg.de), Vivatsgasse 7, 53111 Bonn, Germany. *Stable complexes, reflexive sheaves and monads.* Preliminary report.

One difficulty in constructing moduli of complexes of coherent sheaves is that, quite often, there are no canonical representations for the complexes involved. Using resolutions of reflexive sheaves and monads on projective spaces, I will give very concrete descriptions of certain stable complexes. This allows us to construct some strata of the moduli of stable complexes as global quotient stacks. (Received February 13, 2012)

1081-14-308 **Tommaso de Fernex** and **Roi Docampo*** (docampo@math.utah.edu). *Jacobian discrepancies and rational singularities.*

In this talk I will introduce the notion of Jacobian discrepancy, an extension to singular varieties of the classical definition of discrepancy for morphisms of smooth varieties. This invariants, very natural from the point of view of jet schemes and arc spaces, leads to a framework in which adjunction and inverstion of adjunction hold in full generality. Moreover, they allow us to give explicit formulas measuring the gap between the dualizing sheaf

and the Grauert-Riemenschneider canonical sheaf of a normal variety, leading to characterizations of rational and Du-Bois singularities in the normal Cohen-Macaulay case in terms of Jacobian discrepancies. (Received February 13, 2012)

1081-14-329 **Matthew R Ballard*** (ballard@math.wisc.edu), 480 Lincoln Drive, Madison, WI 53706, and **David Favero** and **Ludmil Katzarkov**. *Variation of geometric invariant theory quotients and semi-orthogonal decompositions of derived categories.*

We describe semi-orthogonal decompositions of derived categories of coherent sheaves arising from VGIT. We extend these semi-orthogonal decompositions to derived categories of coherent factorizations in the presence of a potential. (Received February 13, 2012)

1081-14-343 **Chris Peterson*** (peterson@math.colostate.edu), Department of Mathematics, Colorado State University, Fort Collins, CO 80523-1874. *Connections between real algebraic geometry, topology and combinatorics.* Preliminary report.

This talk will consider several interactions between real algebraic geometry, topology, and combinatorics as well as how numerical computations can be used to not only guide proofs but to also provide proofs. (Received February 14, 2012)

1081-14-345 **Sara Gharahbeigi***, Washington University in St Louis, St Louis, MO 63130. *Regularity of general rational curves on hypersurfaces.*

We show that for a general smooth rational curve on a general hypersurface of degree $d \leq N$ in \mathbb{P}^N , $N \geq 4$, the restriction map of global sections is of maximal rank, and therefore the regularity index of such curves is as small as possible. (Received February 14, 2012)

1081-14-370 **R Paul Horja*** (horja@math.okstate.edu), Department of Mathematics, Oklahoma State University, Stillwater, OK 74078. *Shadows and Gerbes over Toric Stacks.*

I will describe certain modules over the orbifold cohomology and the K-theory of toric Deligne-Mumford stacks whose algebraic construction is inspired by toric mirror symmetry and my joint work with Lev Borisov on the better behaved GKZ system. Some applications and geometrical considerations will be presented. (Received February 14, 2012)

1081-14-373 **Ivan Mirkovic*** (mirkovic@math.umass.edu), Dept of Math, Umass, Amherst, MA 01003. *Representations of semisimple Lie algebras in positive characteristic.* Preliminary report.

This is a report on methods developed with Dmitriy Rumynin, Roman Bezrukavnikov and Simon Riche. (Received February 14, 2012)

1081-14-378 **Colin Diemer*** (diemer@math.miami.edu). *Secondary Stacks and Toric Hypersurface Degenerations.*

The topology of hypersurfaces in toric varieties is largely governed by the structure of triangulations of the corresponding newton polytopes. The combinatorial gadget encoding these triangulation is a by now classical polytope called the secondary polytope. I'll discuss various enhancements of this polytope which afford more refined information about toric hypersurfaces. This is part of joint work with Katzarkov and G. Kerr. (Received February 14, 2012)

1081-14-391 **Julianna S Tymoczko*** (jtymoczko@smith.edu), Department of Mathematics and Statistics, Clark Science Center, Smith College, Northampton, MA 01063. *A combinatorial and geometric representation of the symmetric group.*

Regular semisimple Hessenberg varieties are a family of subvarieties of the flag variety with remarkable symmetries. We will discuss a geometric representation of the symmetric group on the (equivariant) cohomology of the regular semisimple Hessenberg variety and describe different combinatorial contexts in which it arises, including work of Stembridge and exciting recent work of Shareshian and Wachs. (Received February 14, 2012)

1081-14-394 **Dincer Guler***, 8700 NW River Park Dr, Parkville, MO 64152. *Numerical dimension of nef line bundles.*

In this talk we will present a characterization of the numerical dimension of nef line bundles over compact Kahler manifolds in terms of eigenvalues of special metrics defined on the line bundle. (Received February 14, 2012)

1081-14-395 **Erik Lee Carlsson***, 111 College rd. apt. 1A, Selden, NY 11784. *K-theory of moduli spaces of sheaves and large grassmannians.*

I'll present a surprising new formula that characterizes the equivariant pushforward of a bundle on $M_{r,n}$ built by applying Schur functors to the tautological bundle. The proof proceeds from thinking of $M_{r,n}$ as a class

in the K -theory of a large Grassmannian manifold in analogy with the construction of the Hilbert scheme, which is a completely different approach from several papers leading up to it. We find that some elements from Haiman theory surface, such as the Macdonald inner-product on symmetric polynomials, and some "plethystic" vertex operators. If time permits, I'll explain the intended applications to Nekrasov's partition function, and four-dimensional gauge theory. (Received February 14, 2012)

1081-14-405 **John Iskra*** (iskrajohnj@gmail.com), PO Box 947, Emory, VA 24327. *Use of Locales in Algebraic Geometry*. Preliminary report.

In this talk, I will make the case that examining a generalized definition of lisse arrows reveals important differences among categorical models of Algebraic Schemes. In particular, I announce results which, by contrasting the category of locales and the opposite of the category of commutative rings, illuminate both barriers and promising paths on the journey toward a resolution of singularities on algebraic varieties. I am giving this talk at the invitation of Dr. Purna (Received February 15, 2012)

15 ► *Linear and multilinear algebra; matrix theory*

1081-15-43 **Jiu Ding** and **Noah H Rhee***, 5100 Rockhill Road, Kansas City, MO 64110. *On the equality of algebraic and geometric multiplicities of matrix eigenvalues*.

We summarize several equivalent conditions for the equality of algebraic and geometric multiplicities of an eigenvalue for a complex square matrix. As applications, we give new proofs of some important results related to positive matrices and mean ergodic matrices. (Received January 14, 2012)

16 ► *Associative rings and algebras*

1081-16-10 **Liping Li*** (lixxx480@math.umn.edu), 504 Vincent Hall 206 Church St. SE., Minneapolis, MN 55455. *A generalized Koszul theory and its application*.

Let A be a non-negatively graded, locally finite algebra. We develop a generalized Koszul theory by assuming that the degree 0 part A_0 is self-injective instead of semisimple. It turns out that many results in the classical theory generalize to the broader situation. In particular, we obtain the Koszul duality.

This generalized theory can be applied to many algebraic structures which have natural gradings, but the degree 0 parts are not semisimple. These structure includes finite EI categories and directed categories, which are locally finite k -linear categories \mathcal{C} such that there is a partial order \leq on $\text{Ob}\mathcal{C}$ satisfying that $\text{Hom}_{\mathcal{C}}(x, y) \neq 0$ implies $x \leq y$. In particular, we get a nice correspondence between the generalized theory and the classical theory in the context of directed categories.

A preprint of this topic is available at ArXiv: 1109.5760. (Received October 18, 2011)

1081-16-22 **Houssein El Turkey**, Dept. of Mathematics, University of Oklahoma, Norman, OK, and **Jonathan Kujawa***, Dept. of Mathematics, University of Oklahoma, Norman, OK. *Presenting Schur Superalgebras*.

The symmetric group and the Lie superalgebra $\mathfrak{gl}(m, n)$ are in Schur-Weyl duality and the finite dimensional Schur superalgebra acts as the bridge. In the spirit of the work of Doty and Giaquinto in the classical case, we show that the Schur superalgebra has a nice presentation by generators and relations. We also discuss our analogous results in the quantum setting. In particular, our results suggest that geometric constructions in the classical case should have super analogues. (Received December 20, 2011)

1081-16-81 **Yiqiang Li*** (yiqiang@buffalo.edu), Department of Mathematics, 244 Mathematics Building, Buffalo, NY 14260. *On quantum $GL(n)$* .

The quantum $GL(n)$ of Faddeev-Reshetikhin-Takhtajan and Dipper-Donkin are realized geometrically by using double partial flag varieties. As a consequence, the difference of these two Hopf algebras is caused by a twist of a cocycle in the multiplication. (Received January 31, 2012)

1081-16-120 **P. Shan*** (peng.shan@unicaen.fr), **M. Varagnolo** and **E. Vasserot**. *Koszul duality for affine Lie algebras and rational Cherednik algebras*.

I will explain the parabolic-singular Koszul duality for the category \mathcal{O} of affine Lie algebras and explain how to use it to prove Koszulity of q -Schur algebras. I will also discuss the relation with a conjecture of J. Chuang and H. Miyachi on the Koszulity of the category \mathcal{O} of the cyclotomic rational double affine Hecke algebras. (Received February 05, 2012)

1081-16-351 **Kosmas Diveris*** (kjdiveri@syr.edu). *Finitistic extension degree.*

We introduce the finitistic extension degree of a ring and investigate rings for which it is finite. The Auslander-Reiten Conjecture is proved for rings of finite finitistic extension degree and these rings are also shown to have finite finitistic dimension. We apply these results to better understand a generalized version of the Auslander-Reiten Condition for Gorenstein rings. We also examine how finitistic extension degree behaves with respect to many change of ring procedures that arise frequently in the commutative setting. (Received February 14, 2012)

17 ► *Nonassociative rings and algebras*

1081-17-160 **Samuel H Chamberlin*** (samuel.chamberlin@park.edu), Computer Science and Mathematics Department, Park University, 8700 NW River Park Drive, Parkville, MO 64152. *Integral Bases for the Universal Enveloping Algebras of Map Algebras.*

Given a finite-dimensional, simple, complex Lie algebra \mathfrak{g} and A , a commutative, associative algebra with unity over the complex numbers, we exhibit an integral form for the universal enveloping algebra of the map algebra, $\mathfrak{g} \otimes A$, and an explicit integral basis for this integral form. We also produce explicit commutation formulas in the universal enveloping algebra of $\mathfrak{sl}_2 \otimes A$ that allow us to write certain elements in Poincaré-Birkhoff-Witt order. (Received February 09, 2012)

1081-17-185 **Henry H. Kim** and **Kyu-Hwan Lee*** (khlee@math.uconn.edu), Department of Mathematics, University of Connecticut, Storrs, CT 06268-3009. *Rank 2 symmetric hyperbolic Kac-Moody algebras and Hilbert modular forms.*

We study rank two symmetric hyperbolic Kac-Moody algebras $\mathcal{H}(a)$, $a \geq 3$ and their automorphic correction in terms of Hilbert modular forms. We associate a family of $\mathcal{H}(a)$'s to the quadratic field $\mathbb{Q}(\sqrt{p})$ for each odd prime p and show that there exists a chain of embeddings in each family. When $p = 5, 13, 17$, we show that the first $\mathcal{H}(a)$ in each family, i.e. $\mathcal{H}(3), \mathcal{H}(11), \mathcal{H}(66)$, is contained in a generalized Kac-Moody superalgebra whose denominator function is a Hilbert modular form given by a Borcherds product. Hence, our results provide automorphic correction for those $\mathcal{H}(a)$'s. (Received February 10, 2012)

1081-17-213 **Sachin Gautam*** (sachin@math.columbia.edu), Department of Mathematics, Rm 413, MC 4417, Columbia University, 2990 Broadway, New York, NY 10027, and **Valerio Toledano Laredo**. *Geometric representation theory of Nakajima quiver varieties.*

For a Dynkin graph $\Gamma = (I, E)$ of A, D, E type and a dimension vectors $\mathbf{w} \in \mathbb{N}^I$, let $\mathcal{M}(\mathbf{w})$ be the Nakajima quiver variety. The equivariant K -theory of $\mathcal{M}(\mathbf{w})$ admits an action of an infinite-dimensional quantum group, namely the quantum loop algebra $U_q(L\mathfrak{g})$ of simple Lie algebra \mathfrak{g} associated with Γ . Similarly the equivariant cohomology of $\mathcal{M}(\mathbf{w})$ admits an action of the Yangian $Y_{\hbar}(\mathfrak{g})$ of \mathfrak{g} . These symmetries of the quiver varieties were constructed by Nakajima and Varagnolo respectively.

Motivated by the geometric representation theory of Nakajima quiver varieties, we have constructed several homomorphisms of geometric type $U_q(L\mathfrak{g}) \rightarrow Y_{\hbar}(\mathfrak{g})$. In this talk, I will discuss the compatibility between the homomorphisms of geometric type and (certain variants of) the equivariant Chern character relating equivariant K -theory and cohomology of Nakajima quiver varieties. This talk is based on a joint work with V. Toledano Laredo. (Received February 12, 2012)

18 ► *Category theory; homological algebra*

1081-18-65 **Laura Rider*** (lrider1@math.lsu.edu). *A derived Springer correspondence for mixed perverse sheaves.* Preliminary report.

Recall that the Springer correspondence relates representations of the Weyl group to perverse sheaves on the nilpotent cone. We explain how to extend this to a derived equivalence between modules over a graded ring related to W and a certain category of mixed perverse sheaves on the nilpotent cone. (Received January 24, 2012)

1081-18-336 **S. N. Kitchen*** (sarah.kitchen@math.uni-freiburg.de). *Koszul Duality and Mixed Hodge Modules.*

In their paper on Koszul duality, Beilinson, Ginzburg and Soergel indicate that the setting of mixed geometry is the most natural for formulations of statements on Koszul duality. However, their techniques for working with mixed l -adic sheaves and mixed Hodge modules were necessarily different and in the end, their approach to mixed

Hodge modules was quite specific to the B-equivariant geometry of the flag variety. In this talk I will explain joint work with Pramod Achar, where we produce a mixed Koszul category from the category of mixed Hodge modules on a stratified space (with some restrictions on the stratification) by a general procedure. (Received February 14, 2012)

20 ► Group theory and generalizations

1081-20-67 **Rebecca Winarski*** (rebecca.winarski@atlanta.ga.us), 686 Cherry Street, Atlanta, GA 30332. *The Birman Hilden theorem for irregular branched covers.*

Given a covering space $S \rightarrow X$ of surfaces, one may wish to relate the mapping class group of X with the mapping class group of S . The symmetric mapping class group of S is a subgroup of the mapping class group of S consisting of isotopy classes of homeomorphisms that are equivariant. Birman and Hilden proved that if the cover is characteristic, then the mapping class group of X is isomorphic to the symmetric mapping class group of S , modulo the deck group. This isomorphism does not always hold for irregular covers, as shown by Fuller. We give an explicit condition for when the relationship holds for irregular, branched covers. The condition is a finite check of curves on X . (Received January 26, 2012)

1081-20-85 **Mitya Boyarchenko*** (mityab@umich.edu) and **Jared Weinstein**. *Lubin-Tate tower and the local Langlands correspondence.*

We discuss a geometric realization of certain special cases of the local Langlands correspondence and the Jacquet-Langlands correspondence for GL_n over a p -adic field. On the one hand, this geometric construction is related to the Lubin-Tate tower. On the other hand, our proof is purely local and relies on a representation-theoretic result that can be viewed as an analogue of the Deligne-Lusztig construction for unipotent (rather than reductive) groups over finite fields. (Received January 31, 2012)

1081-20-106 **Brian Ray*** (ray8@illinois.edu), 1409 W. Green St., Urbana, IL 61801. *Non-Rigidity of Cyclic Automorphic Orbits in Free Groups.*

We say a subset $\Sigma \subseteq F_N$ of the free group of rank N is *spectrally rigid* if whenever $T_1, T_2 \in \text{cv}_N$ are \mathbb{R} -trees in (unprojectivized) outer space for which $\|\sigma\|_{T_1} = \|\sigma\|_{T_2}$ for every $\sigma \in \Sigma$, then $T_1 = T_2$ in cv_N . Recent results by Carrière, Francaviglia, Kapovich, and Martino motivate the following question: is it true that for any $H \leq \text{Aut}(F_N)$ either for every $1 \neq g \in F_N$, the orbit Hg is rigid or for every $1 \neq g \in F_N$, the orbit Hg is not rigid? We will explain why, in the case H is cyclic, the orbit Hg is never rigid. (Received February 03, 2012)

1081-20-169 **Mustafa Gokhan Benli*** (mbenli@math.tamu.edu). *Presentation problem for the profinite completion of the Grigorchuk group.* Preliminary report.

The Grigorchuk group \mathcal{G} is a finitely generated subgroup of the automorphism group of the binary rooted tree with unusual properties related to the Burnside problem, growth of finitely generated groups, amenability and various other areas of mathematics. Similarly, its profinite completion $\hat{\mathcal{G}}$ has interesting properties in the category of profinite groups. While it was shown that \mathcal{G} is not finitely presented long time ago, the analogous question for $\hat{\mathcal{G}}$ was not investigated so far. In this talk I will present the result which shows that $\hat{\mathcal{G}}$ is not finitely presented in the category of profinite groups. Also various intermediate results about finite quotients of \mathcal{G} will also be presented (Received February 09, 2012)

1081-20-177 **Pramod N. Achar*** (pramod@math.lsu.edu), Department of Mathematics, Louisiana State University, Baton Rouge, LA 70808, and **Anthony Henderson**, **Daniel Juteau** and **Simon Riche**. *Geometric Satake, Springer correspondence, and small representations.* Preliminary report.

This talk is concerned with a kind of “compatibility” between two deep results in geometric representation theory: the geometric Satake isomorphism and the Springer correspondence. Both of these involve realizing representations (of a reductive group G and its Weyl group W , respectively) in terms of perverse sheaves on some variety (the dual affine Grassmannian Gr and the nilpotent cone \mathcal{N} , respectively). I will explain how the geometry of \mathcal{N} is related to that of Gr , as well as what this implies on the representation-theoretic side. For the latter, the notion of *small representations*, which has been studied by Broer and Reeder, plays a key role. (Received February 09, 2012)

1081-20-180 **Yael Algom-Kfir*** (yael.almokfir@yale.edu). *The metric completion of Outer Space.*

Outer space is the space of free, discrete, and minimal isometric actions of F_n on metric trees. It may be endowed with an asymmetric incomplete metric. We prove that its completion is the complex of free splittings.

As a corollary we give a new proof of a theorem of Francaviglia-Martino: The isometry group of Outer Space is $\text{Out}(F_n)$ for $n \geq 3$, and $\text{PGL}(2, Z)$ for $n = 2$. (Received February 09, 2012)

1081-20-188 **Zhaobing Fan*** (fanz@math.ksu.edu), 1545 International Court, M24, Manhattan, KS 66502. *Character sheaves of $GL_n(k[t]/(t^2))$* . Preliminary report.

In 2003, Lusztig constructed generalized character sheaves of $GL_n(k[t]/(t^m))$. He showed that these sheaves behave like character sheaves and conjectured that these are intersection cohomology. In this talk, I will construct a family of perverse sheaves on $GL_n(k[t]/(t^2))$ which are expected to be character sheaves of $GL_n(k[t]/(t^2))$. And I will define induction and restriction functors for them. (Received February 10, 2012)

1081-20-223 **Joel Louwsma*** (jlouwsma@ou.edu), Department of Mathematics, The University of Oklahoma, Norman, OK 73019-3103. *Extremality of the rotation quasimorphism on the modular group*.

It follows from work of Bavard that $\text{scl}(A) \geq \text{rot}(A)/2$ for any element A of the modular group $\text{PSL}(2, \mathbb{Z})$, where scl denotes *stable commutator length* and rot denotes the *rotation quasimorphism*. Sometimes this bound is sharp, and sometimes it is not. We study which elements $A \in \text{PSL}(2, \mathbb{Z})$ have the property that $\text{scl}(A) = \text{rot}(A)/2$. First we describe some experimental results based on computation of stable commutator length. Then we discuss the following stability theorem: for any element of the modular group, the product of this element with a sufficiently large power of a parabolic element is an element that satisfies $\text{scl} = \text{rot}/2$. This result is joint work with Danny Calegari. (Received February 12, 2012)

1081-20-358 **Tara E. Brendle** and **Dan Margalit*** (margalit@math.gatech.edu). *Congruence subgroups of braid groups*.

The braid groups can be embedded into mapping class groups of surfaces, and these embeddings give rise to symplectic representations of braid groups. We aim to characterize the corresponding congruence subgroups of the braid groups, that is, the subgroups of the braid group acting trivially on the mod m homology of the surfaces. Arnol'd proved that the level two subgroup is precisely the pure braid group. We prove that the level four subgroup is the subgroup generated by squares of all Dehn twists. We also study the behavior of these groups under the forgetful maps, where one or more braid strands are forgotten. We prove that the image of the Torelli subgroup of the braid group (the subgroup acting trivially on integral homology) under any forgetful map is the level four subgroup. (Received February 14, 2012)

22 ► Topological groups, Lie groups

1081-22-36 **David Ben-Zvi*** (benzvi@math.utexas.edu), Mathematics Department, University of Texas, 1 University Station C1200, Austin, TX 78751, and **David Nadler**, Mathematics Department, Northwestern University. *Geometric Theory of Harish Chandra Characters*.

We will discuss a general theory of characters in derived algebraic geometry, including Grothendieck-Riemann-Roch and Atiyah-Bott-Lefschetz type formulae for calculating characters. When applied to the action of a reductive group on the category of representations of its Lie algebra, we find a geometric construction of Harish Chandra's characters for admissible representations and deduce the character formulas of Schmid-Vilonen. (Received January 11, 2012)

1081-22-140 **Matthew Housley***, housley@math.byu.edu. *Springer Fibers, Joseph Polynomials and the Temperley-Lieb Algebra*. Preliminary report.

In the context of a complex semisimple Lie algebra \mathfrak{g} , one can define Springer fibers and associated representations of the Weyl group. For each component of a Springer fiber, Anthony Joseph has defined a polynomial which measures the Euler characteristic of Borel-Weil line bundles on the flag variety restricted to this component. The complex span of all polynomials attached to a given fiber is naturally a Weyl group representation isomorphic to the Springer representation. Letting $\mathfrak{g} = \mathfrak{sl}_n(\mathbb{C})$, we exploit facts about associated cycles of Harish-Chandra modules to compute these polynomials for Springer fibers parameterized by two part partitions and uncover a connection with skein theory and the Temperley-Lieb algebra. (Received February 07, 2012)

1081-22-233 **Shamgar Gurevich*** (shamgar@math.wisc.edu), 480 Lincoln Drive, Madison, WI 53706, and **Ronny Hadani** (hadani@math.utexas.edu), 1 University Station C1200, Austin, TX 78712. *The Categorical Weil Representation and the Sign Problem*.

In a previous work the authors gave a conceptual explanation for the linearity of the Weil representation over a finite field k of odd characteristic: There exists a canonical system of intertwining operators between the

Lagrangian models of the Heisenberg representation. This defines a canonical vector space $H(V)$ associated with a symplectic vector space V over k . In the lecture we prove a general theorem about idempotents in categories, and we use it to solve the sign problem, formulated by Bernstein and Deligne, on the compatibility between the associativity constraint and the convolution structure of the l -adic sheaf of canonical intertwining kernels. This sheaf governs—via the sheaf-to-function correspondence—the function theoretic system of intertwiners. As an application we define a canonical category $C(V)$ associated with the symplectic vector space variety V , and we obtain the canonical model of the categorical Weil representation. (Received February 13, 2012)

1081-22-321 **Xinwen Zhu*** (xinwenz@math.harvard.edu), Department of Mathematics, Harvard University, One Oxford Street, Cambridge, MA 02138. *Geometrical Satake for ramified groups*.

I am going to describe a geometrical version of the Satake isomorphism for a quasi-split reductive group over a local field, split over a ramified extension. (Received February 13, 2012)

30 ► *Functions of a complex variable*

1081-30-49 **John L Lewis*** (johnl@uky.edu), Mathematics Department, University of Kentucky, Lexington, KY. *p* *Harmonic Measure Revisited*. Preliminary report.

In this talk I will discuss endpoint type results for p harmonic measure in simply connected domains similar to those obtained for harmonic measure by Makarov. (Received January 17, 2012)

1081-30-83 **Hrant Hakobyan*** (hakobyan@math.ksu.edu), 138 Cardwell Hall, Department of Mathematics, Manhattan, KS 66506. *Quasiconformal geometry of slit carpets*. Preliminary report.

We consider a class \mathcal{S} of Ahlfors 2-regular metric measure spaces which are homeomorphic to the regular Sierpinski carpet, which we call standard slit carpets. In particular we show the following properties:

- $S \in \mathcal{S}$ may be embedded quasisymmetrically into the complex plane \mathbb{C} if and only if it is a Loewner space in the sense of Heinonen and Koskela.
- If S is not QS embeddable into \mathbb{C} then every QS selfmap of S is an isometry.

(Received January 31, 2012)

1081-30-90 **Kai Rajala*** (kai.i.rajala@jyu.fi). *Uniformization of rectifiable surfaces*. Preliminary report.

We discuss conditions under which there exist conformal/quasiconformal maps from a surface with locally finite Hausdorff 2-measure to the euclidean plane. Here a conformal map is by definition a homeomorphism which preserves conformal modulus. (Received February 01, 2012)

1081-30-91 **Leonid V Kovalev*** (lvkova@syr.edu) and **Jani Onninen** (jkonnine@syr.edu). *Quasisymmetric graphs and Zygmund functions*.

A quasisymmetric graph is a curve whose projection onto a line is a quasisymmetric map. We show that this class of curves is related to solutions of the reduced Beltrami equation and to a generalization of the Zygmund class Λ^* . This relation makes it possible to use the tools of harmonic analysis to construct nontrivial examples of quasisymmetric graphs and of quasiconformal maps. (Received February 01, 2012)

1081-30-108 **Mario Bonk*** (mbonk@math.ucla.edu). *Sierpiński carpets as Julia sets*.

By now it is well-known that Sierpiński carpets can arise as Julia sets of rational functions. In my talk I will discuss some results about the quasiconformal geometry of such carpets. This work is in partial collaboration with M. Lyubich and S. Merenkov. (Received February 03, 2012)

1081-30-139 **David Drasin*** (drasin@math.purdue.edu), Department of Mathematics, Purdue University, 150 North University Street, West Lafayette, IN 47907, and **Eero Saksman**. *Slowly-growing frequently hypercyclic entire functions*.

Let T be a linear transformation on a topological vector space X . A vector $x \in X$ is *frequently hypercyclic* if given any neighborhood $N \ni y$, $y \in X$, the orbit $\{T^n x\}$ lies in N for n of positive density in \mathbb{N} ; in this case we call T itself frequently hypercyclic. In our setting, $X = \mathcal{E}$, the entire functions on \mathbb{C} , T is differentiation, and the topology is that of uniform convergence on compacta ($p = \infty$), or L^p -norm: $M_p(r, f) := \int |f(re^{i\theta})|^p d\theta$. The problem of determining the sharp minimal possible growth of frequently hypercyclic functions (depending on $p \in [1, \infty]$) was raised by K. -G. Grosse-Erdmann et al. For $p = \infty$ we obtain the sharp condition $\liminf_r r^{1/4} M_\infty(r, f) > ce^r$,

where $c > 0$. This bound remains sharp for $p \in [2, \infty]$, while varies with p in the range $1 \leq p < 2$. When $p = 1$ the best possible growth rate for frequent hypercyclicity reduces to that for hypercyclicity (where there is no density condition on the frequency that $\{T^n x\}$ enter N).

The Rudin-Shapiro polynomials are key ingredient in the construction of examples which show sharpness. (Received February 07, 2012)

1081-30-254 **Nicolae Tecu*** (nicolae.tecu@gmail.com). *Random conformal weldings at criticality.*

We present an extension to criticality of a random conformal welding result by Astala, Jones, Kupiainen and Saksman by which we obtain closed random curves in the plane. The welding is done by using a random homeomorphism obtained by exponentiating the Gaussian Free Field. (Received February 13, 2012)

1081-30-294 **Anton Isopoussu, Kirsi Peltonen and Jeremy T Tyson***, 1409 West Green St., Urbana, IL 61801. *Quasiregular maps and the conductivity equation in the Heisenberg group.*

The interplay between Beltrami and conductivity equations in the plane was used by Astala and Päivärinta in their celebrated solution of Calderón's inverse conductivity problem in impedance tomography. Using Korányi and Reimann's Beltrami-type equations for Heisenberg quasiconformal and quasiregular mappings, together with the calculus of the horizontal curl operator developed by Franchi-Tchou-Tesi, we extend this interplay to the setting of the first Heisenberg group equipped with its Carnot-Caratheodory metric. In particular, we indicate conditions on a conjugate pair of conductivity solutions which ensure that such functions arise as the horizontal components of a Heisenberg quasiregular mapping. This is joint work with Anton Isopoussu and Kirsi Peltonen. (Received February 13, 2012)

1081-30-311 **Donald E Marshall*** (marshall@math.washington.edu), Prof. Donald E. Marshall, Mathematics Dept Box 354350, University of Washington, Seattle, WA 98195-4350. *Conformal Welding.* Preliminary report.

We will discuss a simple and flexible algorithm for the numerical computation of conformal maps, illustrating its applications to problems of conformal welding for quasitrees, the uniformization of plane domains, and the spectra of certain ODEs. These applications arose in work with J. Barnes, S. Rohde, B. Shapiro, and A. Solynin. (Received February 13, 2012)

1081-30-330 **Daniel Alpay, Aad Dijkstra, Heinz Langer and Dan Volok*** (danvolok@math.ksu.edu), 138 Cardwell Hall, Kansas State University, Manhattan, KS 66506. *A Schur algorithm for a large class of functions.*

In this paper a Schur transformation is introduced for a large class of functions, which includes the generalized Schur functions in the unit disk and the generalized Nevanlinna functions in the upper half-plane. The transformation is used to solve an interpolation problem of the Carathéodory-Fejér type. (Received February 13, 2012)

1081-30-335 **Olena Ostapyuk***, Department of Mathematics, College of Natural Sciences, University of Northern Iowa, Cedar Falls, IA 50614-0506. *Parabolic dynamics in the disk and in the ball.* Preliminary report.

Based on dynamical behavior, all self-maps of the unit disk in the complex plane can be classified as elliptic, hyperbolic or parabolic. The parabolic case is the most complicated one and branches into two subcases - zero-step and non-zero-step cases. In several dimensions, zero-step and non-zero step cases can be defined for sequences of forward iterates, but it is not known yet if the classification can be extended to parabolic maps of the ball. However, some geometric properties of the forward iterates still hold in higher-dimensional case. I will conclude with several open questions and examples. (Received February 14, 2012)

1081-30-338 **Fredrik Johansson Viklund*** (fjv@math.columbia.edu), **Steffen Rohde** and **Carto Wong**. *On the continuity of SLE_κ curves in κ .*

The Schramm-Loewner evolution with parameter $\kappa > 0$ (SLE_κ) is a family of conformally invariant random fractal curves defined by using a standard Brownian motion times the square-root of κ as driving term for the Loewner differential equation. A natural question that seems to have occurred to several researchers is whether the SLE_κ Loewner chains are almost surely simultaneously generated by curves which change continuously when κ varies in an interval and the Brownian motion sample is kept fixed. Indeed, there are examples of Loewner chains with deterministic driving terms strictly more regular than Brownian motion that do not have this property. We will discuss recent joint work with S. Rohde and C. Wong answering this question in the

positive, at least for a range of κ . Time permitting, we will also describe some related quantitative results. (Received February 14, 2012)

1081-30-383 **Tadeusz Iwaniec, Ngin-Tee Koh, Leonid V. Kovalev and Jani Onninen*** (jkonnine@syr.edu), 215 Carnegie Building, Syracuse University, Syracuse, NY 13244. *Energy minimal diffeomorphisms: existence and nonexistence.*

The Riemann Mapping Theorem tells us that planar simply connected domains (different from the entire complex plane) are conformally equivalent. A conformal map is a diffeomorphic solution of the Cauchy-Riemann system. For generic multiply connected domains, however, there is no such mapping. We are interested in solving the Cauchy-Riemann system in the least squares sense. Such diffeomorphic solutions minimize the Dirichlet energy and, therefore, are harmonic. We establish the existence of energy minimal diffeomorphisms between doubly connected planar domains. (Received February 14, 2012)

31 ► Potential theory

1081-31-161 **Frederic Bernicot and Diego Maldonado*** (dmaldona@math.ksu.edu), 138 Cardwell Hall, Manhattan, KS 66506, and **Kabe Moen and Virginia Naibo.** *Bilinear pseudo-Poincare inequalities.*

Motivated by Leibniz-type rules, we develop a bilinear version of the so-called expanded Sobolev-Poincare inequalities. These expanded inequalities arise when replacing averages with approximations to the identity and the challenge is to overcome the lack of localization. (Received February 09, 2012)

32 ► Several complex variables and analytic spaces

1081-32-31 **Sonmez Sahutoglu*** (sonmez.sahutoglu@utoledo.edu), University of Toledo, Department of Mathematics and Statistics, Toledo, OH 43606. *Localization of compactness of Hankel operators on pseudoconvex domains in C^n .*

We prove the following localization for compactness of Hankel operators on Bergman spaces. Assume that Ω is a bounded pseudoconvex domain in C^n , p is a boundary point of Ω , and $B(p, r)$ is a ball centered at p with radius r so that $U = \Omega \cap B(p, r)$ is a domain. We show that if the Hankel operator H_f with symbol $f \in C^1(\bar{\Omega})$ is compact on $A^2(\Omega)$ then H_f is compact on $A^2(U)$ where $A^2(\Omega)$ and $A^2(U)$ denote the Bergman spaces on Ω and U , respectively. (Received January 05, 2012)

1081-32-59 **John P. D'Angelo*** (jpda@math.uiuc.edu). *The X-variety for proper mappings between balls.*

Forstneric showed in 1989 that a proper holomorphic mapping between balls with sufficient boundary regularity must be a rational mapping, assuming the domain dimension is at least two. To do so, he considered a variety extending the graph of the mapping. Assuming that the map is rational, D'Angelo found in 2003 an elegant method for explicitly determining this variety; it is an affine space whose fibers are null spaces of explicit matrices.

In this talk we recall this method and apply it to study homotopy equivalence classes of rational proper mappings between balls. (Received January 23, 2012)

1081-32-68 **Debraj Chakrabarti*** (debraj@math.tifrbng.res.in), TIFR Centre for Applicable Mathematics, Sharada Nagar, Chikkabommasandra, Yelahanka, Bangalore, Karnataka 560065, India. *The $\bar{\partial}$ -equation on the Hartogs Triangle.*

It is known that the $\bar{\partial}$ -problem is not regular on the Hartogs Triangle, i.e., the domain $\{|z_1| < |z_2| < 1\}$ in \mathbb{C}^2 . We discuss the regularity of the $\bar{\partial}$ -problem in weighted Sobolev spaces. Singular weights allow us to understand the blowup of the solution at the singularity. This is joint work with Mei-Chi Shaw of Notre Dame. (Received January 27, 2012)

1081-32-111 **Mei-Chi Shaw*** (shaw.1@nd.edu), Department of Mathematics, University of Notre Dame, Notre Dame, IN 46556. *The range of the Cauchy-Riemann operator in complex manifolds and duality between harmonic and Bergman spaces.*

The closed range property of the Cauchy-Riemann operators for domains in a complex manifold is well understood if the complex manifold is Stein. However, much less is known if the complex manifold is not Stein. Recently, some progress has been made for the L^2 theory of the Cauchy-Riemann equations on product domains in complex manifolds. An analogous formula of the classical Kunnetth formula for the harmonic forms are also obtained.

Furthermore, duality between the harmonic spaces and the Bergman space in complex manifolds will also be presented. Most of these results are recent joint work with Debraj Chakrabarti. (Received February 04, 2012)

1081-32-121 **Phillip Harrington** and **Andrew Raich*** (araich@uark.edu), Department of Mathematical Sciences, 1 University of Arkansas, SCEN 301, Fayetteville, AR 72701.
Closed range for $\bar{\partial}$ on $(0, q)$ -forms and a weak $Z(q)$ -condition.

In this talk, I discuss recent joint work with Phil Harrington in which we define a weak $Z(q)$ condition and prove closed range in H^s for $\bar{\partial}$ for $(0, q)$ -forms under this hypothesis for $-1/2 \leq s \leq 1$. I will also discuss applications including closed range of $\bar{\partial}_b$ and triviality of space of $(0, q)$ harmonic forms. (Received February 06, 2012)

1081-32-126 **Loredana Lanzani*** (lanzani@uark.edu), Mathematics Department, University of Arkansas, Fayetteville, AR 72701, and **Elias M. Stein**. *THE BERGMAN PROJECTION IN L^p FOR DOMAINS WITH MINIMAL SMOOTHNESS.*

Let D be a bounded, strongly Levi-pseudoconvex domain in \mathbb{C}^n with minimally smooth boundary. We prove $L^p(D)$ -regularity for the Bergman projection B , and for the operator $1-B$ whose kernel is the absolute value of the Bergman kernel with p in the range $(1, +\infty)$. As an application, we show that, for each such p , the space of holomorphic functions in a neighborhood of the closure of D is dense in Bergman p -space. (Received February 06, 2012)

1081-32-138 **Dusty Grundmeier**, **Jiri Lebl*** (lebl@math.wisc.edu) and **Liz Vivas**. *Bounding the rank of Hermitian forms and rigidity for CR mappings of hyperquadrics.*

This is joint work with Dusty Grundmeier and Liz Vivas. We prove that the rank of a Hermitian form on the space of holomorphic polynomials can be bounded by a constant depending only on the maximum rank of the form restricted to affine manifolds. As an application we prove a result in the spirit of the Baouendi-Huang and Baouendi-Ebenfelt-Huang rigidity theorems for CR mappings between hyperquadrics. If we have a real-analytic CR mapping of a hyperquadric not equivalent to a sphere to another hyperquadric $Q(A, B)$, then either the image of the mapping is contained in a complex affine subspace or A is bounded by a constant depending only on B . Finally, we will prove a stability result about existence of non-trivial CR mappings of hyperquadrics. That is, as long as both A and B are sufficiently large and comparable, then there exist CR mappings whose image is not contained in a hyperplane. (Received February 08, 2012)

1081-32-170 **Anne-Katrin Herbig**, **Jeffery D. McNeal** and **Emil J. Straube*** (straube@math.tamu.edu). *Duality of holomorphic function spaces and smoothing properties of the Bergman projection.*

Let $\Omega \subset\subset \mathbb{C}^n$ be a domain with smooth boundary, whose Bergman projection B maps the Sobolev space $H^{k_1}(\Omega)$ (continuously) into $H^{k_2}(\Omega)$. We establish two smoothing results: (i) the full Sobolev norm $\|Bf\|_{k_2}$ is controlled by L^2 -norms of derivatives of f taken along a *single, distinguished* direction (of order $\leq k_1$), and (ii) the projection of a *conjugate holomorphic* function in $L^2(\Omega)$ is automatically in $H^{k_2}(\Omega)$. There are obvious corollaries for when B is globally regular. (Received February 09, 2012)

1081-32-174 **Ilya Kossovskiy*** (ilyakos@gmail.com), 24 Kensington Avenue, LONDON, Ontario N6H 1C2, Canada. *Analytic Continuation of Holomorphic Mappings From Non-Minimal Hypersurfaces.*

The classical result of H.Poincare states that a local biholomorphic mapping of an open piece of the 3-sphere in \mathbb{C}^2 onto another open piece extends analytically to a global holomorphic automorphism of the sphere. This theorem was generalized by H.Alexander to the case of the hypersphere in an arbitrary \mathbb{C}^n , $n \geq 2$, then later by S.Pinchuk for the case of strictly pseudoconvex hypersurface in the preimage and a sphere in the image, and finally by R.Shafikov and D.Hill for the case of an essentially finite hypersurface in the preimage and a non-degenerate hyperquadric in the image. In this joint work with R.Shafikov we consider the - essentially new - case of a non-minimal hypersurface M in the preimage. We demonstrate that the above extension results fail in this case, and prove the following analytic continuation phenomenon: a local biholomorphic mapping of M onto a non-degenerate hyperquadric in $\mathbb{C}P^n$ extends to a punctured neighborhood of the complex hypersurface, lying in M , as a multiple-valued local biholomorphic mapping. (Received February 09, 2012)

1081-32-184 **Yunus E Zeytuncu*** (zeytuncu@math.tamu.edu), Texas A&M University Milner Hall, Mailstop 3368, College Station, TX 77843. *Regularity of the Bergman Projection and Stein Neighborhood Bases.*

Let \mathbb{D} denote the unit disk in \mathbb{C} and let $g(z)$ be a bounded holomorphic function on \mathbb{D} . We consider the following class of complete Hartogs domains

$$\Omega_g = \{(z, w) \in \mathbb{C}^2 : z \in \mathbb{D} \text{ and } |w| < |g(z)|\}.$$

We relate the regularity properties of the Bergman projection \mathbf{B}_Ω to the existence of a Stein neighborhood basis on this special class of domains. (Received February 10, 2012)

1081-32-197 **Mehmet Çelik*** (mehmet.celik@unt.edu), University of North Texas at Dallas, Department of Mathematics and Info. Sciences, 7300 University Hills Blvd., Dallas, TX 75241, and **Sönmez Şahutoğlu** (sonmez.sahutoglu@utoledo.edu), University of Toledo, Department of Mathematics and Statistics, 2801 W. Bancroft St., Toledo, OH 43606-3390. *Compactness of the $\bar{\partial}$ -Neumann Operator and Commutator Operator on forms.* Preliminary report.

Connections between compactness of the $\bar{\partial}$ -Neumann operator and compactness of the commutator operator of the Bergman projection and multiplication operator on square integrable forms on pseudoconvex domains will be presented. (This is a work in progress and is a joint work with Sönmez Şahutoğlu.) (Received February 11, 2012)

1081-32-211 **Samangi Munasinghe*** (samangi.munasinghe@wku.edu). *Geometric Sufficient Conditions for Compactness of the $\bar{\partial}$ -Neumann Operator for a Class of Domains.* Preliminary report.

We extend a sufficient condition for compactness of the $\bar{\partial}$ -Neumann operator for a class of domains in \mathbb{C}^n . These conditions were first introduced by Emil Straube for domains in \mathbb{C}^2 and later extended to higher dimensions with an additional assumption. Here we give a modification of the additional assumption for a class of domains. This is work in progress. (Received February 12, 2012)

1081-32-230 **Siqi Fu*** (sfu@camden.rutgers.edu), Department of Mathematical Sciences, Rutgers University-Camden, Camden, NJ 08102. *Covering mappings and the Bergman kernel.*

The transformation formula of the Bergman kernel under proper mappings has played an important role in the study of boundary regularity of these mappings. In this talk, we discuss a generalization of this formula to infinite covering mappings and its applications. (Received February 12, 2012)

1081-32-245 **Dusty E Grundmeier*** (grundmer@umich.edu), Department of Mathematics, 2074 East Hall, 530 Church Street, Ann Arbor, IL 48109-1043. *Group-invariant CR mappings.* Preliminary report.

We consider group-invariant CR mappings from spheres to hyperquadrics. Given a finite subgroup $\Gamma \subset U(n)$, a construction of D'Angelo and Lichtblau yields a target hyperquadric $Q(\Gamma)$ and a canonical non-constant CR map $h_\Gamma : S^{2n-1}/\Gamma \rightarrow Q(\Gamma)$. For every $\Gamma \subset SU(2)$, we determine this hyperquadric $Q(\Gamma)$, that is, the numbers of positive and negative eigenvalues in its defining equation. We will consider extensions of this result to other finite subgroups of $U(2)$. (Received February 13, 2012)

1081-32-268 **Nils Ovreid** (nilsov@math.uio.no), Department of Mathematics, University of Oslo, P.B. 1053 Blindern, Oslo, N-0316, and **Sophia Vassiliadou*** (sv46@georgetown.edu), Department of Mathematics, Georgetown University, St. Mary's Hall, Washington, DC 20057. *L2-d-bar cohomology groups of some singular complex spaces.*

I will discuss the L2-d-bar cohomology groups of the regular part of some complex spaces with isolated singularities. (Received February 13, 2012)

1081-32-314 **David E Barrett*** (barrett@umich.edu). *Critical points of isoperimetric functionals.* Preliminary report.

A smoothly bounded domain $\Omega \subset \mathbb{R}^3$ is a critical point for the isoperimetric functional

$$Q(\Omega) \stackrel{\text{def}}{=} \frac{\text{area}(b\Omega)^{3/2}}{\text{vol}(\Omega)}$$

if and only if $b\Omega$ has constant mean curvature. There are many local examples of surfaces with constant mean curvature, but a famous theorem of Alexandrov states that the only global examples are spheres; of course the isoperimetric inequality tells us that these critical points are in fact minima. The situation for immersed hypersurfaces is quite different: a celebrated construction of Wente shows that there are immersed tori in \mathbb{R}^3 with constant mean curvature.

The talk will review these matters and their corresponding complex analogues, where euclidean surface area is replaced by Fefferman's holomorphically invariant surface measure. (Received February 13, 2012)

1081-32-317 **Michael Jury*** (mjury@uf1.edu), PO Box 118105, Gainesville, FL 32611-8105. *Geometric properties of Schur class mappings of the unit ball in \mathbb{C}^n .*

Let \mathbb{B}^n denote the unit ball in \mathbb{C}^n . A function $b : \mathbb{B}^n \rightarrow \mathbb{B}^n$ is said to belong to the Schur class \mathcal{S}_n if the kernel $(1 - \langle b(z), b(w) \rangle)(1 - \langle z, w \rangle)^{-1}$ is positive semidefinite; that is,

$$\sum_{i,j=1}^m c_i c_j \frac{1 - \langle b(z_i), b(z_j) \rangle}{1 - \langle z_i, z_j \rangle} \geq 0$$

for all finite sets z_1, \dots, z_m in \mathbb{B}^n and all sets of complex numbers c_1, \dots, c_m . When $n > 1$, \mathcal{S}_n is a proper subset of the holomorphic self-maps of the ball. While the study of \mathcal{S}_n was originally motivated by applications in operator theory, it turns out that the functions in \mathcal{S}_n have some geometric properties not shared by general maps of \mathbb{B}^n . In this talk I will survey some of these, related to the Schwarz lemma, angular derivatives, and boundary fixed points. (Received February 13, 2012)

1081-32-340 **Michael D Bolt*** (mbolt@calvin.edu), 1740 Knollcrest Circle SE, Calvin College, Grand Rapids, MI 49546. *Real hypersurfaces with constant Möbius-invariant curvature.*

Let $M^3 \subset \mathbb{C}^2$ be a three times differentiable real hypersurface. The Levi form of M transforms under biholomorphism, and when restricted to the complex tangent space, the skew-hermitian part of the second fundamental form transforms under Möbius transformation. The surfaces for which these forms are constant multiples of each other were identified in previous work, but when the constant was unimodular there was a global condition. Here we present new examples in case the global condition is removed. (Received February 14, 2012)

1081-32-390 **Ronald A Walker*** (rawalker@psu.edu), 777 W Harrisburg Pike, Middletown, PA 17057. *Boundaries of Holomorphic Chains in Holomorphic Vector Bundles.*

The boundaries of holomorphic chains, i.e., linear combinations of analytic varieties, provide a biholomorphic invariant of a complex space. Considerable differences exist between characterizations for boundaries within affine space versus those within projective space. Moreover examples demonstrating phenomena that are a hybrid of both also exist. We present a characterization for boundaries within holomorphic vector bundles over a complex manifold. As a result we see that a range of behavior can be described using a unified framework involving certain $\bar{\partial}$ cohomology groups. (Received February 14, 2012)

1081-32-392 **Dincer Guler***, 8700 NW River Pasrk Dr, Parkville, MO 64152. *Vanishing Theorems on Compact Kahler manifolds.*

In this talk we will discuss two vanishing theorems for compact Kahler manifolds, each of which generalize both the Nadel's vanishing theorem and the Nakano vanishing theorem. (Received February 14, 2012)

34 ► Ordinary differential equations

1081-34-11 **Alan Veliz-Cuba*** (aveliz-cuba2@unl.edu), 203 Avery Hall, Lincoln, NE 68588, and **J. Arthur, L. Hochstetler, V. Klomps** and **E. Korpi**. *On the relationship of continuous and discrete models in systems biology.*

It has been hypothesized that the dynamical behaviour of biological systems strongly depends on the topological features of the wiring diagram. In this talk we will present theoretical results that support this biological hypothesis. Our results show that there is a one to one correspondence between the steady states of a continuous model and the steady states of a discrete model. (Received October 19, 2011)

1081-34-100 **Shuguan Ji*** (jisg@jlu.edu.cn), College of Mathematics, Jilin University, 2699 Qianjin Street, Changchun, Jilin 130012, Peoples Rep of China, and **Weishi Liu** (wliu@math.ku.edu), Department of Mathematics, University of Kansas, 1460 Jayhawk Blvd., 405 Snow, Lawrence, KS 66045. *Poisson-Nernst-Planck Systems for Ion Flow with Density Functional Theory for Hard-Sphere Potential: I-V relations and Critical Potentials.*

In this work, we analyze a one-dimensional steady-state Poisson-Nernst-Planck type model for ionic flow through a membrane channel including ionic interactions modeled from the Density Functional Theory in a simple setting: Two oppositely charged ion species are involved with electro-neutrality boundary conditions and with zero permanent charge, and only the hard sphere component of the excess (beyond the ideal) chemical potential is included. By using a combination of geometric singular perturbation theory and functional analysis, we first

establish the existence result for small ion sizes, and then also derive an approximation of the I-V (current-voltage) relation. For this relatively simple situation, it is found that the ion size effect on the I-V relation can go either way – enhance or reduce the current. More precisely, there is a critical potential value V_c so that, if $V > V_c$, then the ion size enhances the flow; if $V < V_c$, it reduces the current. There is another critical potential value V^c so that, if $V > V^c$, the current is increasing with respect to $\lambda = r_2/r_1$ where r_1 and r_2 are, respectively, the radii of the positively and negatively charged ions; if $V < V^c$, the current is decreasing in λ . (Received February 02, 2012)

1081-34-130 **Carmen Chicone*** (chiconeC@missouri.edu) and **Michael Thomas Heitzman** (heitz1m@cmich.edu). *The phase locked loop, infinite-time averaging and invariant manifolds*. Preliminary report.

Phase locked loops (PLLs) are ubiquitous multi-purpose electronic components—every cell phone has at least one—used for example to demodulate a message encoded in a high-frequency carrier wave. A basic ODE mathematical model will be discussed. The method of averaging is used to determine the demodulation performance of PLLs. The analysis relies on a new result on infinite-time averaging in the presence of attraction. A byproduct of the analysis is a result on the persistence of non-normally hyperbolic invariant tori. (Received February 07, 2012)

1081-34-204 **Wenzhang Huang*** (huangw@uah.edu), Department of Mathematical Sciences, University of Alabama in Huntsville, Huntsville, AL 35899, and **Zhilan Feng**. *Global Dynamics of a Plant-Herbivore Model with Toxin-Determined Functional Response*. Preliminary report.

We study the dynamics of plant-herbivore interactions with toxin-determined functional response. Unlike the traditional Holling Type 2 functional response, the selected toxin-determined functional response loses its monotonicity at high levels of plant-toxicity levels. Systems with non-monotone functional responses are capable of supporting multiple interior equilibria and bistable attractors. Therefore, identifying conditions that guarantee global stability is not only mathematically challenging but important to scientists. We are able to find necessary and sufficient condition on the non-existence of a closed orbit via the transformation of the model to a new equivalent system. The Poincare-Bendixson theorem is used to show that the existence of a unique interior equilibrium point guarantees its global asymptotical stability whenever it is locally asymptotically stable. When there are multiple interior equilibria, it is shown that the local stability of the “first interior equilibrium” implies model bistability and that the phase space is separated by two sub-regions: the basins of attraction of two stable equilibria - the interior and the boundary equilibria. (Received February 11, 2012)

1081-34-287 **Zoi Rapti*** (zrapti@illinois.edu), Department of Mathematics, University of Illinois at Urbana-Champaign, Urbana, IL 61801. *Breather Stability in Klein-Gordon Equations*.

We will present results on breather stability in Klein-Gordon equations. First, we will show an algorithm that relates the type of multibreathers – where oscillators can be at rest, in or out of phase – to the number of negative eigenvalues in the perturbation matrix. The perturbation is with respect to the case without coupling between the oscillators. This analysis has been done for discrete Klein-Gordon chains and interactions with up to three neighbors away and weak coupling. In every case a direct count of the unstable eigenvalues can be made. Next, we will show results for continuous Klein-Gordon equations that are approximations of the discrete ones. In particular, we investigate the role of interactions with farther neighbors. (Received February 13, 2012)

1081-34-372 **Na Long*** (longna@ksu.edu), 1225 Bertrand Avenue, Apt B, Manhattan, KS 66502. *Constrained two-body problem*. Preliminary report.

We will study a system of differential equations motivated by the N-body problems from classical mechanics. We will attempt to find solutions of this system by exploiting the geometry of the problem. For N equal to 2, the masses must follow trajectories that are conic sections, a fact that was known classically. Amazingly, for N greater than or equal to 3 the problem is almost intractable and no satisfactory complete solution to the problem is known. So we will find the motion of two masses in space as in the 2-body problem with the additional condition that the motion is constrained to lie on a 2-dimensional surface in 3-space. That is, the two masses can only move along the surface of some 2-dimensional object. We will start with two simpler problems of the constrained two-body problem. The first one is that two masses can only move along two parallel lines. The second one is that two masses can only move within two parallel planes. From both cases, we can show that the motion of the two masses is periodic. (Received February 14, 2012)

1081-34-375 **Roger Nichols*** (nicholsrog@missouri.edu), Mathematics Department, 202 Mathematical Sciences Bldg, University of Missouri, Columbia, MO 65211, and **Fritz Gesztesy** (gesztesyf@missouri.edu) and **Steve Hofmann** (hofmanns@missouri.edu). *On Square Root Domains for Non-Self-Adjoint Operators Under Additive Perturbations*. Preliminary report.

Following Kato, we define the sum, $H = H_0 + V$, of two linear operators, H_0 and V , in a fixed Hilbert space in terms of its resolvent. In an abstract theorem, we present conditions on V that guarantee $\text{dom}(H_0^{1/2}) = \text{dom}(H^{1/2})$ (under certain sectorality assumptions on H_0 and H). Concrete applications to non-self-adjoint Schrödinger-type operators—including additive perturbations of uniformly elliptic divergence form partial differential operators by singular complex potentials on domains—where application of the abstract theorem yields $\text{dom}(H^{1/2}) = \text{dom}((H^*)^{1/2})$, will be presented. (Received February 14, 2012)

35 ► *Partial differential equations*

1081-35-18 **Russell K. Jackson*** (rkjacks@usna.edu). *Horseshoes and hand grenades: on Schrödinger, standing waves and stability*.

In dynamical systems, the horseshoe map is a fundamental object of study. A horseshoe brings order out of chaos, providing a catalog of distinguished solutions by drawing an equivalence between the dynamics on its attractor and the dynamics of a shift map on a finite symbol space.

In this talk, we look for standing waves in nonlinear Schrödinger-type equations with a periodic or N-well potential; these equations have been used to model optical propagation in a waveguide as well as Bose-Einstein condensation in a lattice. We simplify the strategy of “shooting for standing waves” in this model by detailing the construction of a horseshoe. The horseshoe’s geometry will vary depending upon the prescribed nonlinearity (attracting, repulsive or competing), but in each case, the mere presence of a horseshoe allows us to instantly identify a huge assortment of standing waves.

Moreover, when a shooting method is used to pinpoint a standing wave, a second shooting method in a related space can often be used to locate eigenvalues of the linearized operator at the standing wave. In the present case, this eigenvalue information is also encoded into the horseshoe, and we discuss how to quickly decode this information and determine the stability properties of each wave. (Received December 14, 2011)

1081-35-20 **Bjorn Sandstede*** (bjorn_sandstede@brown.edu), 182 George Street, Providence, RI 02912. *Nonlinear stability of defects*.

Defects are interfaces that mediate between two wave trains with possibly different wave numbers. Of particular interest in applications are sources for which the group velocities of the wave trains to either side of the defect point away from the interface. While sources are ubiquitous in experiments and can be found easily in numerical simulations of appropriate models, their analysis still presents many challenges. One difficulty is that sources are not travelling waves but are time-periodic in an appropriate moving coordinate frame. A second difficulty is that perturbations are transported towards infinity, so that weighted norms cannot be used. In this talk, I will discuss nonlinear-stability results for sources that rely on pointwise estimates. I plan to focus on two different problems, namely (i) a toy problem that captures the essential features of general sources and (ii) on the Nozaki-Bekki holes of the complex Ginzburg-Landau equation. (Received December 19, 2011)

1081-35-30 **Yuan Lou*** (lou@math.ohio-state.edu), Department of Mathematics, Ohio State University, Columbus, OH 43016. *Ideal free distribution and evolution of dispersal*.

A general question in the study of the evolution of dispersal is what kind of dispersal strategies can convey competitive advantages and thus will evolve. We mainly focus on a reaction-diffusion advection model for two competing species, in which the species are assumed to have the same population dynamics but different dispersal strategies. We found a conditional dispersal strategy which results in the ideal free distribution of species, and we investigate whether such dispersal strategy is evolutionarily stable. Discrete and nonlocal dispersal models will also be discussed. This talk is based upon joint works with Isabel Averill, Steve Cantrell, Chris Cosner, Dan Munther and Dan Ryan. (Received January 02, 2012)

1081-35-32 **Blake Barker***, Blake Barker, Rawles Hall, 831 E 3rd St, Bloomington, IN 47405, and **Mathew Johnson, Miguel Rodrigues, Pascal Noble** and **Kevin Zumbrun**. *A Numerical Study of Stability of Periodic Kuramoto-Sivashinsky Waves*.

We consider the spectral and nonlinear stability of periodic traveling wave solutions of a generalized Kuramoto-Sivashinsky equation. In particular, we resolve the long-standing question of nonlinear modulational stability by

demonstrating that spectrally stable waves are nonlinearly stable when subject to small localized (integrable) perturbations. We carry out a numerical Evans function study of the spectral problem and find bands of spectrally stable periodic travelling waves, in close agreement with previous numerical studies of Frisch-She-Thual, Bar-Nepomnyashchy, Chang-Demekhin-Kopelevich, and others carried out by other techniques. We also compare predictions of the associated Whitham modulation equations, which formally describe the dynamics of weak large scale perturbations of a periodic wavetrain, with numerical time evolution studies, demonstrating their effectiveness at a practical level. (Received January 05, 2012)

1081-35-33 **Peter Howard*** (phoward@math.tamu.edu), Texas A&M University, Department of Mathematics, College Station, TX 77843. *Short-time existence theory toward stability for nonlinear parabolic systems.*

In the pointwise semigroup approach to stability for nonlinear waves large-time bounds on perturbations must be coupled with appropriate short-time bounds in order to close an iteration on Duhamel-type integral equations. Since the emphasis of such analyses is clearly on long-time behavior, it is preferable to develop the short-time theory under minimal assumptions. In this talk I will discuss a new short-time existence result for classical solutions of nonlinear parabolic systems in divergence form on \mathbb{R}^n , under mild regularity assumptions on coefficients in the problem, and under the assumption of Hölder continuous initial conditions. (Received January 09, 2012)

1081-35-37 **Anna R Ghazaryan*** (ghazarar@muohio.edu), Oxford, OH 45056, and **Stephen Schecter** and **Peter Simon**. *Fronts in a model for gasless combustion with heat loss.*

We consider a model of gasless combustion with heat loss, with the heat loss from the system to the environment modeled according to Newton's law of cooling. In the regime when the system contains two small parameters, a diffusion coefficient for the fuel and a heat loss parameter, we use Geometric Singular Perturbation theory to show existence of traveling combustion fronts, then use a combination of analytic and numerical methods to study their linear and nonlinear stability. (Received January 12, 2012)

1081-35-38 **Shibin Dai*** (sdai@math.msu.edu), Department of Mathematics, Michigan State University, East Lansing, MI 48824, and **Keith Promislow**. *Motion of bi-layers governed by the functionalized Cahn-Hilliard equation.*

The functionalized Cahn-Hilliard equation is introduced as a phase field model to describe the evolution of complex nanoscale structures similar to those observed in Polymer Electrolyte Membrane (PEM) fuel cells. Such complex structures include single layers, bi-layers, pore networks and micelles, etc. We concentrate on the motion of a closed bi-layer. Using asymptotic analysis, we derive its leading order normal velocity in different time scales. In a faster time scale, the motion is determined by a Stefan type problem. In a slower time scale, the normal velocity is proportional to the mean curvature, with a time-dependent factor that decays to zero. In the slowest time scale, the normal velocity is determined by the mean and Gaussian curvatures and the total area of the bi-layer is preserved. (Received January 13, 2012)

1081-35-39 **Andrew Comech*** (comech@math.tamu.edu), Mathematics Department, Texas A&M University, Mailstop 3368, College Station, TX 77843-3368, and **Nabile Boussaid** (nboussai@univ-fcomte.fr), Laboratoire de Mathématiques, Université de Franche-Comté, 25030 Besançon, France. *On the linear instability of nonlinear Dirac equation.*

We consider the spectrum of the nonlinear Dirac equation linearized at a solitary wave. While the essential spectrum is always located on the imaginary axis, there could be point eigenvalues with positive real part, which indicate the linear instability of a particular solitary wave. We present several results on where such eigenvalues can or can not come from. The results are based on Georgescu's Hardy-type and Carleman-type inequalities. (Received January 13, 2012)

1081-35-44 **Felipe LINARES**, **Didier PILOD*** (didier@im.ufrj.br) and **Jean-Claude SAUT**. *THE CAUCHY PROBLEM FOR STRONGLY DISPERSIVE TWO-DIMENSIONAL SURFACE WAVES.*

Boussinesq systems are a three-parameter family of asymptotic models for weakly nonlinear surface waves. The eigenvalues of their dispersion matrix are pseudo-differential operators of order between -1 and 3 . We will describe recent results on the Cauchy problem for the more dispersive ones (order 2 and 3) with emphasize on the order 3 case which is a new (system) generalization of the KdV equation in two space dimensions. (Received January 16, 2012)

1081-35-47 **Seungly Oh*** (soh@math.ku.edu), University of Kansas, 405 Snow Hall, 1460 Jayhawk Blvd, Lawrence, KS 66045, and **Atanas Stefanov**. *An Improved Local Well-posedness Result for the Periodic "Good" Boussinesq Equation*. Preliminary report.

We prove that the "good" Boussinesq model with the periodic boundary condition is locally well-posed in the space $H^s \times H^{s-2}$ for $s > -3/8$. In the proof, we employ the normal form approach, which allows us to explicitly extract the rougher part of the solution. This also leads to the conclusion that the remainder is in a smoother space $C([0, T], H^{s+a})$, where $0 \leq a < \min(2s + 1, 1/2)$. If we have a mean-zero initial data, this implies a smoothing effect of this order for the non-linearity. This is new even in the previously considered cases $s > -1/4$. (Received January 17, 2012)

1081-35-58 **Luca Capogna*** (lcapogna@uark.edu). *Stability of the doubling property and Poincare inequality in a Riemannian approximation of Carnot-Carathéodory metrics*.

Given a system of smooth vector fields X_1, \dots, X_m in R^n , satisfying the Hörmander finite rank condition one can consider a class of Riemannian metrics g_ϵ in R^n such that as $\epsilon \rightarrow 0$ the associated metric d_ϵ converges in the Gromov-Hausdorff sense to the Carnot-Carathéodory metric generated by X_1, \dots, X_m . Doubling and Poincare inequalities hold for every $\epsilon \geq 0$. For $\epsilon = 0$ these are crucial results of Nagel-Stein-Wainger and of Jerison respectively.

In a joint work with Giovanna Citti (Bologna) and Garrett Rea (Findlay) we prove that the constants in the doubling and Poincare inequalities can be chosen independently of ϵ . We also apply this stability result to prove regularity for a class of weak solutions of degenerate parabolic quasi-linear PDE. (Received January 23, 2012)

1081-35-61 **Alex A. Himonas***, Department of Mathematics, University of Notre Dame, Notre Dame, IN 46556, and **Curtis Holliman** (cho11iman@ms.soph.uab.edu), Department of Biostatistics, University of Alabama at Birmingham, Birmingham, AL 35294. *On the Cauchy problem of the CH and DP equations*.

We shall discuss the initial value problem for the Camassa-Holm (CH) and the Degasperis-Procesi (DP) equations with data in Sobolev spaces H^s . In particular, for $s < 3/2$ we shall show that these equations are not well-posed. (Received January 23, 2012)

1081-35-66 **Murat Akman*** (makman@ms.uky.edu), **John L Lewis** and **Andrew Vogel**. *On the logarithm of the minimizing integrand for certain variational problems in two dimensions*. Preliminary report.

Let f be smooth convex homogeneous function of degree p , $1 < p < \infty$, on $\mathbb{C} \setminus \{0\}$ and $v \in W^{1,p}(\Omega)$. In this paper we study that if u is a minimizer for the functional whose integrand is $f(\nabla v)$, and $\nabla u \neq 0$ at $z \in \Omega$, then in a neighborhood of z , $\log f(\nabla u)$ is a subsolution for $p > 2$, supersolution for $p < 2$ and solution for $p = 2$ to L where

$$L\xi = \sum_{k,j=1}^2 \frac{\partial}{\partial x_k} (f_{\eta_k \eta_j}(z) \frac{\partial \xi}{\partial x_j}).$$

(Received January 26, 2012)

1081-35-73 **Marius Beceanu** and **Michael Goldberg*** (goldbeml@ucmail.uc.edu), Department of Mathematical Sciences, University of Cincinnati, Cincinnati, OH 45221-0025. *Estimates for the Wave Equation with a Rough Potential*.

Abstract: We prove several families of bounds for the linear wave equation in \mathbf{R}^3 driven by $H = -\Delta + V(x)$, where the class of admissible potentials includes the Lorentz space $L^{3/2,1}(\mathbf{R}^3)$. The estimates include a full range of dispersive and Strichartz inequalities, as well as an additional collection of Strichartz-type bounds in the mixed spaces $L_x^p L_t^q$.

As a corollary we discover that solutions in the energy space are almost-everywhere continuous with respect to time. (Received January 30, 2012)

1081-35-88 **Yuri Latushkin*** (latushkiny@missouri.edu), Department of Mathematics, University of Missouri, Columbia, MO 65211, and **Alin Pogan**. *The infinite dimensional Evans function*.

We introduce generalized operator valued Jost solutions of first order ill-posed differential equations on Hilbert spaces. We then construct an infinite dimensional Evans function for abstract differential equations as a 2-modified Fredholm determinant of the operator obtained by adding the values at zero of the generalized operator valued Jost solutions. Next, we prove a formula that connects the 2-modified Evans determinant and the 2-modified determinant related to the Birman-Schwinger type operator associated to the ill-posed equation. Using this formula, we construct a holomorphic infinite dimensional Evans function for second order differential

operators on infinite cylinders whose zeros are the eigenvalues of the differential operators. (Received February 01, 2012)

1081-35-96 **Todd Kapitula*** (tmk5@calvin.edu), Department of Mathematics and Statistics, Calvin College, Grand Rapids, MI 49546. *Index Theorems for Quadratic Pencils with Applications.*

In dispersive wave equations which are second-order in time, e.g., sine-Gordon and the “good” Boussinesq, the linearized eigenvalue problem associated with the spectral stability of a wave can be realized as a quadratic pencil, where each coefficient of the pencil is either a self-adjoint or skew-symmetric operator. There is a well-developed unstable eigenvalue index theory for linear pencils (going back to Grillakis, Jones, etc., and continuing to Pelinovsky, K/Kevrekidis/Sandstede, etc.), which arise when discussing generalized KdV, coupled systems of Schrödinger equations, etc.; however, the theory is not as well established for quadratic pencils. In this talk I will discuss the extension of the linear theory to the quadratic theory, and apply the theoretical results to the study of the spectral stability of spatially periodic waves. (Received February 02, 2012)

1081-35-98 **Wenxian Shen*** (wenxish@auburn.edu), Department of Mathematics and Statistics, Auburn University, Auburn, AL 36849, and **Xiaoxia Xie.** *Approximations of Random Dispersal Operators/Equations by Nonlocal Dispersal Operators/Equations.* Preliminary report.

Both random dispersal and nonlocal dispersal evolution equations are widely used to model diffusion systems in applied sciences. This talk is concerned with the approximations of random dispersal operators/equations by nonlocal dispersal operators/equations. It first proves that the solutions of properly rescaled nonlocal dispersal initial-boundary value problems converge to the solutions of the corresponding random dispersal initial-boundary problem. Next, it proves that the principal spectrum points of time and/space periodic nonlocal dispersal operators with properly rescaled dispersal kernels and Dirichlet type or Neumann type or periodic boundary condition converge to the principal eigenvalue of the corresponding time and/or space periodic random dispersal operator with Dirichlet or Neumann or periodic boundary condition. Finally, it proves that the unique positive periodic solutions of nonlocal dispersal KPP equations with properly rescaled dispersal kernels converge to the unique positive periodic solution of the corresponding random dispersal KPP equation. The above results show that the dynamics of random dispersal equations can be well approximated by properly rescaled nonlocal dispersal equations. (Received February 02, 2012)

1081-35-102 **Markus Keel**, The University of Minnesota, Minneapolis, 55455, and **Shuanglin Shao***, The University of Kansas, Lawrence, KS 66045. *A remark on the two dimensional water wave problem with surface tension.*

This is a joint work with Markus Keel. We consider the motion of a periodic interface between air (above) and an irrotational, incompressible, inviscid, infinitely deep body of water (below), with surface tension present. Drawing from the previous work of S. Wu and D. Ambrose-N. Masmoudi, we present a simpler way to reduce the equations of motion to a quasilinear system in variables related to the interface’s tangent angle and a quantity related to the difference of tangential velocities of the interface in the Lagrangian and arc-length coordinates. We also establish an a-priori energy inequality for the system. (Received February 03, 2012)

1081-35-105 **Mohammad A. Rammaha*** (mrammaha1@math.unl.edu), Department of Mathematics, University of Nebraska-Lincoln, Lincoln, NE 68588-0130. *Monotone Operator Theory and Applications to PDE’s.*

In this talk, I will focus on the treatment of hyperbolic PDE’s under the influence of *supercritical interior and boundary sources*. The local solvability of such problems is hopeless via standard fixed point theorems or Galerkin approximations, due to the lack of compactness.

I will describe a general strategy that can handle the local solvability of most monotone problems by using nonlinear semi-groups (Kato’s Theorem). However, nonlinear semi-groups can only accommodate a globally Lipschitz perturbation of a monotone problem. Thus, going from globally Lipschitz sources to the full generality of supercritical sources will require a great effort. In addition, I will discuss some recent results on convex integrals on Sobolev spaces (generalization to old results by Brézis-1972) which are essential to this strategy. (Received February 03, 2012)

1081-35-150 **Robert L Pego*** (rpego@cmu.edu), **Tetsu Mizumachi** and **José Raúl Quintero.** *Asymptotic stability of solitary waves in a water wave model with indefinite variational structure.*

We study asymptotic stability properties for solitary waves in the Benney-Luke model equation for water waves. One feature that this model shares with the full water wave problem is that solitary wave profiles are critical

points of an energy-momentum functional that is infinitely indefinite and not useful for estimates. (Received February 08, 2012)

1081-35-157 **King-Yeung Lam***, lam.184@osu.edu, and **Yuan Lou** and **Wei-Ming Ni**. *PDE vs ODE Dynamics*.

Dynamics, or behaviour of solution of nonlinear reaction-diffusion system is deeply related to that of its kinetic problem. In this lecture, we will use the classical Lotka-Volterra competition model as an example to illustrate some connections between the two. Also, the asymptotic behavior of the principal eigenvalue of linear cooperative elliptic systems, as the diffusion rates approach zero, will be motivated and studied. (Received February 08, 2012)

1081-35-172 **Eduard-Wilhelm Kirr*** (ekirr@math.uiuc.edu) and **Vivek Natarajan**. *Global Bifurcations and Stability of Bound States in Nonlinear Schrödinger Equations*.

An open problem in nonlinear dispersive equations is the asymptotic completeness conjecture which states that any initial data eventually converges to a superposition of coherent states. A big obstacle in solving the conjecture is the fact that the set of coherent states is unknown. I will present recent results which find all coherent (bound) states in one dimensional Schrödinger equation and make significant progress in higher dimensions. This is joint work with Vivek Natarajan (U. of Illinois). (Received February 09, 2012)

1081-35-183 **Yanqiu Guo*** (s-yguo2@math.unl.edu), Department of Mathematics, University of Nebraska, Lincoln, NE 68588, and **Mohammad A. Rammaha** (mrammaha1@math.unl.edu), Department of Mathematics, University of Nebraska, Lincoln, NE 68588. *Blow up of solutions to systems of nonlinear wave equations with supercritical sources and damping*.

We study a system comprised of two coupled nonlinear wave equations, subject to interior and boundary supercritical sources and damping. If the sources are more dominant than the damping, we prove that every weak solution to our system blows up in finite time, provided the initial energy is negative. Also we have a blow-up result for potential well solutions with positive initial energy. (Received February 10, 2012)

1081-35-186 **Michael W Frazier*** (frazier@math.utk.edu), **Fedor Nazarov** and **Igor E Verbitsky**. *Global Estimates for Kernels of Neumann Series and Green's Functions for Schrödinger operators of Fractional Order*. Preliminary report.

Consider a linear operator T with operator norm $\|T\| < 1$, and the associated Neumann series $I + T + T^2 + \dots$ for the inverse of $I - T$. Suppose T is an integral operator on $L^2(\Omega)$, where Ω is a σ -finite measure space. Suppose the kernel K of T is non-negative, measurable, symmetric, and satisfies a certain quasi-metric condition (example: the Riesz potential). We show that the kernel H of $S = T + T^2 + T^3 + \dots$ is bounded below by $Ke^{c_1 K_2/K}$ and above by $Ke^{c_2 K_2/K}$, where K_2 is the kernel of T^2 , for constants $c_1, c_2 > 0$.

We apply this result to obtain estimates for Green's functions associated with (possibly fractional) Schrödinger operators $(-\Delta)^{\alpha/2} - q$ for $q \geq 0$ and $0 < \alpha \leq 2$, on a domain Ω which could be all of \mathbb{R}^n , or a bounded domain which satisfies the boundary Harnack principle. Applications to Schrödinger equations are discussed. These results can be restated as estimates for the conditional gauge of an α -stable process.

Solvability criteria for a certain nonlinear equation of Riccati type can be obtained as an application. (Received February 10, 2012)

1081-35-198 **Jiahong Wu*** (jiahong@math.okstate.edu), Department of Mathematics, Oklahoma State University, 401 Mathematical Sciences, Stillwater, OK 74078. *The surface quasi-geostrophic equation and its generalizations*.

This talk is divided into two parts. The first part summarizes results on the global regularity issue concerning the surface quasi-geostrophic (SQG) equation with critical or supercritical dissipation. The second part focuses on several generalized versions of the SQG equations. These generalized equations are active scalar equations with the velocity fields determined by the scalars through general Fourier multiplier operators. They reduce to the SQG equation when the operator is given by the Riesz transform. Results from several recent papers on the generalized SQG equations (in collaboration with D. Chae, P. Constantin, D. Cordoba and F. Gancedo) will be presented. (Received February 11, 2012)

1081-35-214 **Christopher W Curtis*** (christopher.w.curtis@colorado.edu), 526 UCB, Dept. of Applied Mathematics, Boulder, CO 80302, and **Mark J Ablowitz**. *Conservation Laws and Perturbations of KP Web-Solutions*. Preliminary report.

The Benney-Luke (BL) equation is a first order approximation of water waves which yields the Kadomtsev-Petviashvili (KP) equation in a quasi one-directional limit. An effective method using conservation laws of the KP equation is developed which determines the slow evolution of parameters of two space dimensional, non-decaying web-type solutions approximating the Benney-Luke equation. Numerical simulations are given which support the analytical results and elucidates the relationship between the KP and the BL equations. (Received February 12, 2012)

1081-35-215 **Ognyan Borisov Christov*** (christov@fmi.uni-sofia.bg), 1164 Sofia, Bulgaria. *On the nonlocal symmetries of the μ -Camassa-Holm equation*.

The μ -Camassa-Holm (μ CH) equation is a nonlinear integrable partial differential equation closely related to the Camassa-Holm and the Hunter-Saxton equations. This equation admits quadratic pseudo-potentials which allow us to compute some first order non-local symmetries. As applications, a Darboux-like transformation is constructed and its recursion operator is recovered. Finally, we discuss also the associated μ CH equation. (Received February 12, 2012)

1081-35-220 **George Avalos*** (gavalos@math.unl.edu), Department of Mathematics, University of Nebraska-Lincoln, Lincoln, NE 68588. *Concerning the uniform of a structural acoustic PDE model*.

In this talk we shall address a longstanding problem of deriving uniform decay rates for a partial differential equation (PDE) system which has been invoked in the literature to model an interior acoustic wave flow, subjected to structurally damped flexural boundary vibrations. By way of describing this phenomenon, the governing PDE will evince a coupling of distinct hyperbolic and parabolic dynamics, this coupling being accomplished across a boundary interface. The novelty in our work will be the attainment of uniform rational decay rates for smooth solutions of the PDE, in the absence of any inserted dissipation on the inactive portion of the boundary. The proof of this result will necessitate the appropriate use of a recently derived stability resolvent criterion of A. Borichev and Y. Tomilov. (Received February 12, 2012)

1081-35-222 **Mat Johnson*** (matjohn@math.ku.edu). *Stability of Periodic Wave Trains in a Kuramoto-Sivashinsky Equation*.

In this talk, we consider the spectral and nonlinear stability of periodic traveling wave solutions of a dispersion modified Kuramoto-Sivashinsky equation modeling viscous thin film flow down an inclined plane. In special cases, it has been known (with varying levels of rigor) since 1976 that, when subject to weak localized perturbations, spectrally stable solutions of this form exist. Although numerical time evolution studies indicate that these waves should also be nonlinearly stable to such perturbations, an analytical verification of this result has only recently been provided. In this talk, I will discuss a nonlinear stability theory for such spectral stability periodic wave trains, as well as the numerical and analytical verification of the required spectral stability and structural hypothesis of this theorem in particular canonical limits of dispersion/dissipation. This is joint work with Blake Barker and Kevin Zumbrun (Indiana University), as well as Pascal Noble and L. Miguel Rodrigues (University of Lyon I). (Received February 14, 2012)

1081-35-241 **Vahagn Manukian*** (manukive@muohio.edu), Miami University Hamilton, 1601 University Blvd, Hamilton, OH 45011. *Various families of traveling wave solutions of Gray-Scott model*.

For a wide range of parameter values we show the existence of rich families of traveling waves of the Gray-Scott model. We find pulse solutions, periodic wave trains, families of fronts that connect constant states, constant states to a periodic wave train, two periodic wave trains, a periodic orbit to a pulse train. In certain singular limits we pinpoint the structure of the traveling waves. The results are anchored in geometric singular perturbation theory. (Received February 13, 2012)

1081-35-252 **Vera Mikyoung Hur*** (verahur@math.uiuc.edu) and **Jared Bronski**. *Modulational stability and variational structure*.

I will discuss stability or instability under long wave perturbations of periodic, traveling wave solutions to a broad class of Hamiltonian systems in one spatial dimension, under certain structural assumptions. In particular, I will describe an instability criterion in terms of conserved quantities of the equation. In the proof, a perturbation analysis of the linearized operator replaces Evans function-based approaches. I will illustrate how the abstract framework applies to Korteweg-de Vries type equations with fractional dispersion. (Received February 13, 2012)

- 1081-35-258 **Ioan Bejenaru***, bejenaru@math.uchicago.edu, and **A Ionescu, C Kenig and D Tataru**. *Equivariant Schroedinger Maps in 2D with large data*.
I will talk about the global regularity of equivariant maps in two dimensions with large data. (Received February 13, 2012)
- 1081-35-260 **David Cruz-Uribe** and **Kabe Moen***, P.O. Box 870350, Tuscaloosa, AL 35487, and **Virginia Naibo**. *Regularity of solutions to degenerate p -Laplacian equations*.
Motivated by mappings of finite distortion, we consider degenerate p -Laplacian equations whose ellipticity condition is satisfied by the distortion tensor and the inner distortion function of such a mapping. Assuming a certain Muckenhoupt type conditions on the weight involved in the ellipticity condition, we describe the set of continuity of solutions. (Received February 13, 2012)
- 1081-35-264 **Jared C Bronski*** (jared@math.uiuc.edu), 1409 W Green St, Urbana, IL 61801, and **Lee DeVille** and **Moon Jip Park**. *Stability and the Synchronization Phase transition in the Kuramoto model*.
We consider the Kuramoto model for coupled phase oscillators, a canonical model for synchronization phenomenon. Models like the Kuramoto model are believed to govern systems as disparate as the blinking of fireflies and the unstable oscillations observed in the Millenium Bridge. We analyze the stability of synchronized solutions, deriving an index result counting the dimension of the unstable manifold to such solutions. We use this to prove rigorously the existence of a phase transition in the model. Interestingly the phase transition does not occur in the scaling regime typically considered for this problem. Rather, the transition occurs at a range of coupling constants that is greater by a logarithmic factor. We explain this discrepancy in terms of extreme value statistics. (Received February 13, 2012)
- 1081-35-267 **Roman Shvydkoy*** (shvydkoy@math.uic.edu), 851 S Morgan St, M/C 249, Chicago, IL 60607, and **Dongho Chae**. *On formation of a locally self-similar collapse in the incompressible Euler equations*.
We examine the question a locally self-similar blow-up scenario in the incompressible Euler equations. A new treatment of the local energy equality is used to find a number of verifiable L^p -criteria based on velocity or vorticity. Homogeneous profiles are excluded on all cases except those that allow explicit solutions. The results are compared to numerically observed self-similar formations of vortex dodecapoles indicating the necessity of non-smoothed modeling. (Received February 13, 2012)
- 1081-35-270 **Marcelo Cavalcanti, Irena Lasiecka** and **Daniel Toundykov*** (dtoundykov2@unl.edu). *Stabilization of wave equations with Wentzell boundary conditions*.
I will discuss uniform stabilization of wave equations subject to second-order boundary conditions. Both dynamic (Wentzell) and static (with higher derivatives in space only) boundary conditions will be considered. In contrast to Dirichlet or Neumann-type problems where stability can be achieved via a boundary velocity feedback, in a Wentzell-type system boundary damping alone may not be sufficient for uniform dissipation. It will be shown how a combination of a partially localized boundary feedback and a partially localized collar feedback leads to uniform energy decay rates. The analysis combines weighted multiplier methods used to establish observability of wave dynamics under Neumann conditions and differential-geometric techniques for studying stability of waves on compact manifolds. (Received February 13, 2012)
- 1081-35-276 **Svetlana Roudenko*** (roudenko@gwu.edu), The George Washington University, Washington, DC 20052. *Global behavior of solutions to the focusing nonlinear Schrödinger Equation*. Preliminary report.
We study the behavior of solutions to the focusing nonlinear Schrödinger Equation (NLS) with finite energy data (i.e. in Sobolev H^1 class) with nonlinearities and in dimensions where the NLS is mass-supercritical (for example, with the cubic nonlinearity in dimensions $d \geq 3$). The global behavior of solutions has been understood in the energy-critical and -subcritical cases of NLS under the so-called energy (or mass-energy) threshold, where depending on the kinetic energy, or the initial size of the gradient, either global existence (and scattering) or finite-time blow up occurs. We investigate solutions above such a threshold. By using variance we show that solutions with initial data in a certain range above this threshold can be classified for global existence vs. finite-time blow up. In particular, we discuss the behavior of the modulated ground state solution. We further discuss the criteria and dynamics of blow up solutions. (Received February 13, 2012)

1081-35-279 **Yongki Lee*** (ykleee@iastate.edu) and **Hailiang Liu** (hliu@iastate.edu). *Thresholds in three-dimensional restricted Euler-Poisson equations.*

This work provides a description of the critical threshold phenomenon in multi-dimensional restricted Euler-Poisson (REP) equations, introduced in [H.Liu and E. Tadmor, *Comm. Math. Phys.* 228 (2002), 435–466]. For three dimensional REP equations, we identified both upper-thresholds for finite time blow-up of solutions and sub-thresholds for global existence of solutions, with thresholds depending on the relative sizes of the initial density and the eigenvalues of the initial velocity gradient matrix. These one-sided threshold conditions of initial configurations are sharp and correspond to several situations of physical interest. For attractive forcing case, these results also hold for arbitrary n -dimensions ($n \geq 3$). (Received February 13, 2012)

1081-35-286 **Timur Akhunov*** (takhunov@ucalgary.ca), 2500 University Dr NW, Calgary, AB T2N 1N4, Canada. *Initial Value Problem for the quasilinear dispersive PDE.* Preliminary report.

A general method for wellposedness of the quasilinear systems of PDE of order 2 and higher is presented. The method, inspired by work of Kenig-Ponce-Vega for the quasilinear Schrödinger equation, relies on a priori L^2 estimates. The key to those estimates, in turn, is creating a proper positive commutator. (Received February 13, 2012)

1081-35-290 **David Cruz-Uribe SFO, José María Martell and Cristian Rios*** (crios@ucalgary.ca), Department of Mathematics and Statistics, 2500 University Dr. NW, Calgary, AB T2N1N4, Canada. *Off diagonal estimates and Riesz transforms for weighted elliptic operators.* Preliminary report.

We obtain Gaffney-type estimates that hold for operators with ellipticity controlled by a Muckenhoupt weight. We then apply off-diagonal techniques of Auscher and Martell to obtain L^p estimates for the square root of the operator. (Received February 13, 2012)

1081-35-293 **Chongsheng Cao and Dipendra Regmi*** (dregmi@math.okstate.edu), Oklahoma State University, and **Jiahong Wu**. *The 2D Anisotropic Magnetohydrodynamic Equations.*

We study the global regularity issue concerning the 2D incompressible magnetohydrodynamic (MHD) equations with horizontal dissipation and horizontal magnetic diffusion. We establish a global bound for the L^{2r} -norm of the horizontal component of the velocity and of the magnetic field for any $1 \leq r < \infty$ and the bound grows no faster than the order of $\sqrt{r \log r}$ as r increases. A global L^q -bound, $1 \leq q \leq 3$, for pressure is also obtained. In addition, we establish a conditional global regularity in terms of the $L_t^2 L_x^\infty$ -norm of the horizontal component and the global regularity of a slightly regularized version of the aforementioned MHD equations. (Received February 14, 2012)

1081-35-304 **Necibe Tuncer***, necibe-tuncer@utulsa.edu. *Radially Projected Finite Elements for Pattern Formation on Spheroidal Surfaces.*

We develop and analyze a numerical method to approximate solutions of reaction diffusion systems defined on arbitrary surfaces. In particular, we are interested in reaction diffusion systems that model pattern formation on arbitrary surfaces. Such systems have numerous applications; examples include patterns on seashells and tropical fish, and butterfly wing pigmentation. The method we propose is based on radially projected finite elements. The power of the numerical method is that it is easy to implement, and all computations are done in logically rectangular coordinates (Received February 13, 2012)

1081-35-322 **Ning Ju*** (ning.ju@okstate.edu), 401 Mathematical Sciences, Stillwater, OK 74078. *Energy decay of weak solutions of the Navier-Stokes equations and related fluid equations in the whole space.*

In his celebrated 1934 paper, Leray raised the problem of energy decay for weak solutions of the Navier-Stokes equations for a viscous in-compressible fluid in the whole physical space. Ever since then, this problem has been studied extensively by many researchers. It has been proven that for a Leray weak solution, if it is initially L_p -integrable for some $p \in [1, +\infty]$ in addition to $p = 2$, then its energy decays to zero at least algebraically with respect to time. Under more restrictive conditions, it can even decay exponentially. However, in general situation without any additional assumptions, the energy of a Leray weak solution is only proved to decay to zero, but with the decay rate left un-manueverable for years. It has been indicated in existing mathematical literature that, *in general*, the energy decay would *not* be *uniform* and would be *arbitrarily slow*. Nevertheless, this claim has not been fully justified in rigorous sense. Recent work of the speaker proves that *uniform energy decay bound does exist for general Leray weak solutions*, thus providing a conclusive answer to this open problem. The result can be extended to several other similar fluid equations. (Received February 13, 2012)

1081-35-331 **Zhiwu Lin*** (zlin@math.gatech.edu), 686 Cherry St., Atlanta, GA 30332. *Instability of Periodic Water Waves.*

Periodic traveling waves exist in 2D water waves and lots of dispersive models, such as Stokes waves of deep water (Stokes, 1847) and Cnoidal waves of KDV equation. I will discuss an unified approach to study the stability and instability of periodic waves of water waves and a large class of dispersive models, under perturbations of the same period. The results include a sharp instability criterion for KDV and BBM type models, and a proof of the existence of unstable Stokes waves under some natural assumptions. (Received February 14, 2012)

1081-35-337 **J. Douglas Wright*** (jdoug@math.drexel.edu). *Well-posedness Issues in Degenerate Dispersive Equations.*

Linear dispersion plays a fundamental role in the study of a large number of physical scenarios and has been the subject of intense theoretical development in recent years. Consequently there has been an explosion of results concerning nonlinear dispersive equations. Nevertheless there are situations in which the mechanism which creates dispersion is itself nonlinear and degenerate. Examples can be found in the study of sedimentation, magma dynamics, granular media, numerical analysis and elasticity. Little is understood about general well-posedness issues for such equations. In this talk we will discuss some recent results which show that degenerate dispersive effects can result in catastrophic instability akin to a backwards heat equation. The key step is the construction of a self-similar solution by means of dynamical systems techniques. (Received February 14, 2012)

1081-35-344 **Weishi Liu** (wliu@math.ku.edu), Department of Mathematics, University of Kansas, 405 Snow Hall, Lawrence, KS 66045, and **Myunghyun Oh*** (myoh@ku.edu), Department of Mathematics, University of Kansas, 405 Snow Hall, Lawrence, KS 66045. *Instability of transonic waves of a viscous isentropic gas flow through a nozzle with natural viscosity.*

In this work, we examine the stability of stationary non-transonic waves for viscous isentropic compressible flows through a nozzle with varying cross-section areas. The main result in this paper is, for small viscous strength, stationary non-transonic waves with sufficiently low density are spectrally unstable; more precisely, we will establish the existence of positive eigenvalues for the linearization along such waves. The result is achieved via a center manifold reduction of the eigenvalue problem. The reduced eigenvalue problem is then studied in the framework of the Sturm-Liouville Theory. (Received February 14, 2012)

1081-35-349 **Walter M Rusin*** (wrusin@usc.edu), Department of Mathematics, 3620 S Vermont Ave, KAP 108, Los Angeles, CA 90089. *Large data solutions of 3D incompressible Navier-Stokes equations.*

We consider the three dimensional, incompressible Navier-Stokes equations with periodic boundary conditions. In this talk, we present and discuss some natural conditions on initial data, which guarantee existence of global solutions. The talk is based on joint work with Igor Kukavica. (Received February 14, 2012)

1081-35-354 **Alin Pogan*** (apogan@indiana.edu), 831 East 3rd St, Department of Mathematics, Bloomington, IN 47405. *Traveling waves in reaction-diffusion equations coupled to a conservation law.*

We discuss traveling waves solutions bifurcating from stable layers in the case of nonlinear reaction-diffusion equations coupled to a conservation law. Our general model includes models such as the Keller-Segel model for chemotaxis and thermodynamic phase transitions models. This is joint work with Arnd Scheel. (Received February 14, 2012)

1081-35-355 **Xiao-Biao Lin** and **Stephen Schecter*** (schecter@ncsu.edu), Department of Mathematics, North Carolina State University, Box 8205, Raleigh, NC 27695. *Concatenated Traveling Waves.* Preliminary report.

Concatenated traveling waves look like one traveling wave at the left and another, with greater velocity, at the right. An example is what happens if one lights a fuse in the middle: combustion fronts travel in both directions.

Doug Wright and Sabrina Selle have independently developed a stability theory of concatenated traveling waves in dissipative partial differential equations. Their work views concatenated waves as a sum of waves.

This is somewhat unnatural and leads to results that are not optimal. For example, if the left traveling wave approaches its left state at a fast exponential rate and the right traveling wave approaches its left state at a slow exponential rate, the sum will approach the left state at a slow exponential rate. This is not what actually occurs.

I will present an alternate approach to stability of concatenated traveling waves. An approximate solution consists of one traveling wave at the left, another at the right, and the sum of the waves in a middle region. Exact nearby solutions can be treated using linearization at each traveling wave, and linearization at the appropriate

constant state in the middle. We use Laplace transform to solve the linear problems and to eliminate jumps in the solution across the boundaries between regions. (Received February 14, 2012)

1081-35-359 **Stephane Lafortune*** (lafortunes@cofc.edu), Department of Mathematics, College of Charleston, 175 Calhoun Street, Charleston, SC 29401, and **Andrew N.W. Hone** (A.N.W.Hone@kent.ac.uk), School of Mathematics, Statistics and Actuarial Science, University of Kent, Kent, England. *Stability of solutions for nonintegrable peakon equations*. Preliminary report.

The Camassa-Holm equation with linear dispersion was originally derived as an asymptotic equation in shallow water wave theory. Among its many interesting mathematical properties, which include complete integrability, perhaps the most striking is the fact that in the case where linear dispersion is absent it admits weak multi-soliton solutions - “peakons” - with a peaked shape corresponding to a discontinuous first derivative. There is a one-parameter family of generalized Camassa-Holm equations, most of which are not integrable, but which all admit peakon solutions. Numerical studies reported by Holm and Staley indicated changes in the stability of these and other solutions as the parameter varies through the family. In this presentation, I describe analytical results on one of these bifurcation phenomena, showing that in a suitable parameter range there are stationary solutions which are orbitally stable. (Received February 14, 2012)

1081-35-362 **Gregory D Lyng***, Department of Mathematics, University of Wyoming, 1000 E University Ave, Dept. 3036, Laramie, WY 82071-3036. *Refined Stability of Combustion Waves*.

We describe the extension of Zumbrun & Serre’s refined stability condition to a hierarchy of models for reacting mixtures of gases. We expect that this condition will play an important role in detecting the transition to instability and the development of complex patterns in the propagation of combustion waves. Notably, the key coefficient in the refined stability condition has an interpretation as an “effective viscosity” for transversely propagating waves, and our analysis lays bare the contribution of both the physical viscosity and the reactive structure to this coefficient. This is joint work with Benjamin Texier (Paris7). (Received February 14, 2012)

1081-35-376 **Maksym V Pryporov*** (pryporov@iastate.edu), Iowa State University, Department of Mathematics, 400 Carver Hall, Ames, IA 50011. *Error estimate for the Bloch band-based Gaussian beam superposition for the Schrödinger equation*.

This work is concerned with asymptotic approximation of a semi-classical Schrödinger equation in periodic media. For the underlying equation, subject to a highly oscillatory initial data, a hybrid of the WKB approximation and homogenization leads to the Bloch eigenvalue problem and an associated Hamilton–Jacobi system for the phase in each Bloch band. We formulate a superposition of Bloch-band based Gaussian beams to generate high frequency solutions to the original problem. For initial data of a sum of finite number of band eigen- functions, we prove that the Gaussian beam superposition converges to the original wave field at a rate of $\varepsilon^{1/2}$ as long as the initial data for Gaussian beam components in each band are prepared with same order of error or smaller. (Received February 14, 2012)

1081-35-387 **John Paul Albert*** (jalbert@ou.edu) and **Santosh Bhattarai** (sbhattarai@math.ou.edu), Dept. of Mathematics, University of Oklahoma, 601 Elm Ave, Rm 423, Norman, OK 73019. *Stability of coupled solitary waves for an NLS-KdV system*.

For equations such as the nonlinear Schrödinger equation (NLS) or Korteweg-de Vries equation (KdV), there is a standard method for using their Hamiltonian structure to study solitary-wave solutions, which propagate via symmetries (translation for KdV and translation and phase rotation for NLS). The method is based on the fact that solitary waves are critical points of the Hamiltonian for fixed values of the conserved quantities which arise from the symmetries via Noether’s theorem. In particular, when the critical points are minimizers, stability properties of the solitary waves can be deduced.

One way to prove existence of minimizers is to rule out loss of compactness of minimizing sequences by establishing the subadditivity of the minimum Hamiltonian with respect to the constraint variables. For NLS or KdV, this is easy, but for Hamiltonian systems in which a NLS equation is coupled to a KdV equation, even for the simplest (and most universal) choice of coupling terms, proving subadditivity has been difficult in the past. Here we give a straightforward method for proving subadditivity and thus obtaining stability of coupled solitary waves. It should apply as well to more general minimization problems with multiple constraints. (Received February 14, 2012)

- 1081-35-389 **Maksym Pryporov*** (pryporov@iastate.edu), Iowa State University, Department of Mathematics, 400 Carver Hall, Ames, IA 50011. *Error estimate for the Bloch band-based Gaussian beam superposition for the Schrödinger equation.*

This work is concerned with asymptotic approximation of a semi-classical Schrödinger equation in periodic media. For the underlying equation, subject to a highly oscillatory initial data, a hybrid of the WKB approximation and homogenization leads to the Bloch eigenvalue problem and an associated Hamilton–Jacobi system for the phase in each Bloch band. We formulate a superposition of Bloch-band based Gaussian beams to generate high frequency solutions to the original problem. For initial data of a sum of finite number of band eigen- functions, we prove that the Gaussian beam superposition converges to the original wave field at a rate of $\varepsilon^{1/2}$ as long as the initial data for Gaussian beam components in each band are prepared with same order of error or smaller. (Received February 14, 2012)

- 1081-35-400 **Milena Stanislavova*** (stanis@math.ku.edu), University of Kansas, 405 Snow Hall, 1460 Jayhawk Blvd, Lawrence, KS 66045, and **Atanas Stefanov** and **S. Hakkaev**. *Linear Stability Analysis for Periodic Traveling Waves of the Boussinesq Equation and the KGZ System.*

We study the linear stability of spatially periodic waves for the Boussinesq equation (for the quadratic and cubic models) and the Klein-Gordon-Zakharov system. For a wide class of solutions, we completely and explicitly characterize their linear stability (instability respectively), when the perturbations are taken with the same period. In particular, our results allow us to completely recover the linear stability theorems for the whole line case. (Received February 14, 2012)

- 1081-35-404 **Blake Barker** and **Jeffrey Humpherys*** (jeffh@math.byu.edu), Department of Mathematics, Brigham Young University, Provo, UT 84602, and **Gregory Lyng** and **Kevin Zumbrun**. *Spectral stability of shock layers in compressible fluid flow.*

We review the recent developments in our group’s study on the stability theory for high Mach number viscous shock layers in multi-D compressible fluid flow, as well as detonation waves in reactive flow. In particular, we discuss the substantial challenges observed when computing the Evans function in Eulerian coordinates at high frequencies. We then show how we can overcome these problems by transforming into canonical and somewhat general coordinates. The results are surprising. (Received February 15, 2012)

37 ► *Dynamical systems and ergodic theory*

- 1081-37-41 **Wenxian Shen**, Department of Mathematics and Statistics, Auburn University, Auburn, AL 36849, and **Aijun Zhang*** (azhang@math.ku.edu), Department of Mathematics, University of Kansas, Lawrence, KS 66045. *Traveling Wave Solutions of Spatially Periodic Nonlocal Monostable Equations.*

This talk deals with front propagation for monostable equations with nonlocal dispersal in spatially periodic habitats. Firstly, we will show that a general spatially periodic monostable equation with nonlocal dispersal has a unique spatially periodic positive stationary solution and has a spreading speed in every direction. Then we will show that, with the assumption of the existence of principal eigenvalue, there are unique stable periodic traveling wave solutions to a spatially periodic nonlocal monostable equation connecting its unique positive stationary solution and the trivial solution in every direction with all propagating speeds greater than the spreading speed in that direction. (Received January 14, 2012)

- 1081-37-57 **Oleg Ivrii*** (ivrii@math.harvard.edu), 1 Oxford St., Cambridge, MA 02138. *Ghosts of the Mapping Class Group.*

Recently, McMullen showed that the Weil-Petersson metric in Teichmüller theory arises as the double derivative of the Hausdorff dimension of certain families of quasi-circles arising from simultaneous uniformization. He noticed that a similar construction can be carried out on spaces of Blaschke products; and so by analogy one can define a Weil-Petersson metric there. But how does this metric look like? Is it incomplete? Invariant under the mapping class group?

While it appears that there is no genuine mapping class group acting on the space of Blaschke products, there are ‘ghosts’ acting on two very different boundaries that arise from non-tangential and horocyclic degenerations. In this talk, we will describe these boundaries and illuminate these ghosts. (Received January 23, 2012)

1081-37-72 **Adrian Jenkins*** (ajenkins@iastate.edu), Department of Mathematics, Iowa State University, 378 Cardwell Hall, Ames, IA 50010. *Comparisons and contrasts between non-archimedean dynamics and complex dynamics.*

Over the past few years, in joint work with Steven Spallone of TIFR, we have considered the theory of locally analytic dynamical systems in the non-archimedean setting, and in particular, the local conjugacy classes of mappings tangent to the identity in one variable, or other resonant cases in several variables. In the complex setting, such problems have been studied for well over a century.

This talk will discuss some of the contrasts and comparisons of the theories, with a focus on our own work in the field. Also, there will be a discussion of current problems on which we are working. (Received January 29, 2012)

1081-37-101 **Alexander Adam Azzam*** (adamazzam@gmail.com), University of Nebraska–Lincoln, Department of Mathematics, 203 Avery Hall, Lincoln, NE 68503. *Embroidering in Banach Space.*

An operator T on a Banach space \mathcal{X} is said to be \mathcal{M} -hypercyclic for a subspace \mathcal{M} provided there exists a vector whose orbit under T is dense in \mathcal{M} . The well-researched case $\mathcal{X} = \mathcal{M}$ has provided an elegant solution to the Invariant Subset Problem in addition to establishing unexpected properties of operators. For example, the Bourdon-Feldman theorem proves that if $\text{Orb}(T, x)$ is somewhere dense in \mathcal{X} , then $\text{Orb}(T, x)$ is everywhere dense. Indeed, despite their rigid structure, the dynamics of linear operators can be fantastically complex. What is less predictable, however, is the behavior of an operator in the proper subspaces of \mathcal{X} . In this talk, we'll show that the analogue of the Bourdon-Feldman theorem for the case $\mathcal{M} \subsetneq \mathcal{X}$ is false. We'll do so by proving a theorem of independent interest, that given any relatively open set \mathcal{U} of a proper subspace of X there exists a bounded linear operator dense only in \mathcal{U} . Advised by Dr. Blair Madore (SUNY Potsdam). Joint work with Shelby Heinecke (MIT), Sarah Rasco (SUNY Potsdam), and Oscar Zatarain (UAEH) at the 2011 SUNY Potsdam/Clarkson REU. (Received February 02, 2012)

1081-37-127 **Yingfei Yi*** (yi@math.gatech.edu), School of Mathematics, Georgia Institute of Technology, Atlanta, GA 30332. *Degeneracy, Complexity, and Robustness of Bio-systems.*

There has been recent emphasis on degeneracy as a feature of structural complexity due to the empirical observations of degenerate properties in known complex systems. The notion of degeneracy was first introduced for neural system as the ability of elements that are structurally different to perform the same function. Degeneracy is known to have close ties with structural complexity and robustness of a neural system. It is already observed for neural systems that high degeneracy not only yields high robustness, but also it is accompanied by an increase in the system complexity. In this talk, we will introduce the notions of degeneracy and structural complexity for a biosystem modelled by a differential equation. We will also discuss their connections with the robustness of the system.

This is a joint work with G. Dwivedi (Georgai Tech), W. Huang (USTC), M. Kemp (Georgia Tech) and Y. Li (Georgia Tech). (Received February 06, 2012)

1081-37-146 **Nan Lu** and **Chongchun Zeng***, zengch@math.gatech.edu. *Local invariant manifolds in normally elliptic type singular perturbations.*

We consider a dynamical system, possibly non-autonomous and/or generated by a PDE, with fast and slow time scales which is oscillatory with high frequencies in the fast directions. We first derive and justify the limit system of the slow variables. Assuming a steady state persists, we construct the local stable, unstable, center-stable, center-unstable, and center manifolds of the steady state of sizes of order $O(1)$ and give their leading order approximations. Finally, we show some applications. (Received February 08, 2012)

1081-37-168 **Mingji Zhang*** (mzhang0129@yahoo.com), Department of Mathematics, University of Kansas, 405 Snow Hall 1460 Jayhawk Blvd., Lawrence, KS 66045-7594, and **Weishi Liu** (wliu@math.ku.edu), Department of Mathematics, University of Kansas, 405 Snow Hall 1460 Jayhawk Blvd., Lawrence, KS 66045-7594. *Multiple solutions of Poisson-Nernst-Planck systems for ion channels.*

In this talk, we consider a one-dimensional Poisson-Nernst-Planck (PNP) model for ionic flow through ion channels for two ion species with permanent charges. The PNP model problem can be viewed as a boundary value problem of a singularly perturbed system and existence of solutions is reduced to that of an algebraic system. Multiple solutions are shown to exist, under some conditions, through bifurcation analysis and numerical computations are consistent with our analysis. Existence of multiple solutions in such or similar models might be relevant to some complex behaviors of ion channels. (Received February 09, 2012)

1081-37-224 **Timothy Dorn*** (tdorn@math.ku.edu) and **Weishi Liu**. *Steady states for shear flow in a liquid crystal model.*

We study the steady states for shear flow in a liquid-crystal model for friction. The model is motivated by geological fault flows and is analogous to the Leslie Erickson continuum theory for nematic type liquid-crystals. We give a complete characterization of the existence and multiplicity of steady state solutions as well as spectral stability results concerning the bifurcation of steady states. (Received February 12, 2012)

1081-37-232 **Arnd Scheel**, 127 Vincent Hall, 206 Church ST SE, Minneapolis, MN 55455, and **Qiliang Wu*** (wuxxx410@umn.edu), 127 Vincent Hall, 206 Church ST SE, Minneapolis, MN 55455. *Dynamics near Turing patterns in Reaction-Diffusion Systems.*

We present results on the dynamics near stationary spatially periodic (Turing) patterns in one-dimensional reaction-diffusion systems. We motivate robust spectral stability assumptions and derive linear stability in L^p - L^q spaces. The linear analysis is based on Floquet-Bloch decompositions. We then show how techniques inspired by classical normal form transformations can help understand nonlinear dynamics near Turing patterns. (Received February 12, 2012)

1081-37-259 **Russell Lodge*** (rlodge@indiana.edu), 3803 E Cobble Creek Dr, Bloomington, IN 47401. *Beyond the Twisted Rabbit*. Preliminary report.

The Thurston characterization and rigidity theorem gives a beautiful description of when a postcritically finite topological branched cover mapping the 2-sphere to itself is Thurston equivalent to a rational function. Thurston equivalence remains mysterious, but great strides were taken when Bartholdi and Nekrashevych used iterated monodromy groups to solve the “Twisted Rabbit Problem” which sought to identify the Thurston class of the rabbit polynomial composed with an arbitrary Dehn twist. I will present an invariant for Thurston equivalence that has successfully solved the twisting problem for a degree 3 rational function. (Received February 13, 2012)

1081-37-269 **Hermen Jan Hupkes*** (hupkesh@missouri.edu), 202 Mathematical Sciences Bldg, Columbia, MO 65203, and **Erik Van Vleck**. *Negative Diffusion in High Dimensional Lattice Systems - Travelling Waves.*

We consider bistable reaction diffusion systems posed on rectangular lattices in two or more spatial dimensions. The discrete diffusion term is allowed to have a negative coefficient. We show how travelling wave solutions to the pure lattice system can be approximated by travelling wave solutions to a system that incorporates both local and non-local diffusion. (Received February 13, 2012)

1081-37-315 **Aaron Hoffman***, aaron.hoffman@olin.edu. *Orbital stability of localized structures via Backlund transform.*

The Backlund Transform, first developed in the context of differential geometry, has been classically used to obtain multi-soliton states in completely integrable infinite dimensional dynamical systems. It has recently been used to study the stability of these special solutions. We offer here a dynamical perspective on the Backlund Transform, prove an abstract orbital stability theorem, and demonstrate its utility by applying it to the sine-Gordon equation and the Toda lattice. (Received February 13, 2012)

1081-37-318 **Rafael de la Llave** and **Nikola P. Petrov*** (npetrov@ou.edu), Department of Mathematics, University of Oklahoma, 601 Elm Ave., Norman, OK 73019, and **Arturo Olvera**. *A shadowing theorem with localization, with applications to heteroclinic cycles and to properties of scaling exponents.*

We present a shadowing theorem that works for infinite dimensional discrete dynamical systems that are not necessarily invertible. It has several features: (A) It does not require that the pseudo-orbit considered is hyperbolic, only approximately so. (B) It obtains localization properties, namely, that if the pseudo-orbit fails to be an orbit at some isolated times, the changes needed to make it into a true orbit are exponentially localized around these isolated times.

As an application, we show that, if a map (possibly non-invertible) in a Banach space has two hyperbolic fixed points such that the unstable manifold of each point intersects transversely the stable manifold of the other, then we there exists hyperbolic orbits that visit neighborhoods of the fixed points and stay close to them for any sequence of times we want. We obtain bounds on the position of the stable and unstable subspaces at the points of the periodic orbit.

Applying this theorem to renormalization group operators, we show that some geometric properties of the action of these operators in the function space imply certain asymptotic relations among universal scaling exponents - a fact observed numerically by the authors. (Received February 13, 2012)

1081-37-332 **Spencer Dowdall*** (dowdall@illinois.edu), Department of Mathematics, 1409 W. Green Street, Urbana, IL 61801, and **Jayadev Athreya**. *Shrinking targets in moduli space*. Preliminary report.

It is well-known that, given any ball in the moduli space of Riemann surfaces, almost every Teichmüller geodesic intersects the ball infinitely often. Indeed, this is a straightforward consequence of the ergodicity of the Teichmüller geodesic flow. In this talk, I will discuss a refinement of this question, the so-called “shrinking target problem”, which asks whether a unit-speed geodesic intersects a shrinking family of balls infinitely often. Our main theorem shows that this holds for almost every unit tangent vector provided that the radii of the balls tend to zero fast enough. From this we also derive a logarithm law for the speed at which a generic geodesic approaches a given point in moduli space. This is joint work with J. Athreya. (Received February 14, 2012)

1081-37-368 **Charles Lamb*** (clamb@math.ku.edu) and **Erik Van Vleck**. *Systems of Neutral Equation of Mixed Type*.

We consider a prototype nerve fiber model containing coupling between two parallel nerve fibers. In particular, we consider traveling wave solutions which give rise to a system of neutral mixed type equations. We employ the developed linear theory and continuation methods to demonstrate the existence of solutions for small values of the coupling parameter. In addition, we present numerical results examining the nature of the bifurcated traveling wave solutions while varying several model parameters. (Received February 14, 2012)

1081-37-377 **Maila Brucal Hallare*** (mbrucal@math.ku.edu), 405 Snow Hall, Jayhawk Blvd, Department of Mathematics, University of Kansas, Lawrence, KS 66045. *Entire Solutions of a Lattice Differential Equation over an Inhomogeneous Medium*.

We establish the existence of entire solutions of the lattice differential equation

$$\dot{u}_j = d_j(u_{j-1} - u_j) + d_{j+1}(u_{j+1} - u_j) + u_j(u_j - a)(1 - u_j), \quad d_j > 0, j \in \mathbb{Z}, t \in \mathbb{R},$$

in the case when there is a defect at the node $j = 0$. This is done by applying the comparison principle and constructing an appropriate super-solution, sub-solution pair that are each defined using the traveling wavefront solution of the homogeneous case, that is, when $d_j = d$, for some sufficiently large $d > 0$. The results can be extended to a finite number of defects of the medium. (Received February 14, 2012)

42 ► *Fourier analysis*

1081-42-24 **Oleksandr (Alexander) V. Tovstolis*** (atovstolis@math.okstate.edu), Department of Mathematics, Oklahoma State University, 401 Mathematical Sciences, Stillwater, OK 74078. *Fourier multipliers in Hardy spaces in tubes over open cones and their applications*.

We consider the class $\mathcal{M}_{p,q}(T_\Gamma)$ of Fourier multipliers from Hardy spaces $H^p(T_\Gamma)$ to $H^q(T_\Gamma)$, $0 < p \leq q \leq 1$, in tubes over a regular cone $\Gamma \subset \mathbb{R}^n$.

Theorem. Assume that a function $\varphi \in C(\mathbb{R}^n)$ satisfies $\text{supp } \varphi \subset [-\sigma, \sigma]^n$ for some $\sigma > 0$. If $\widehat{\varphi} \in L^q(\mathbb{R}^n)$ for some $q \in (0, 1]$, then $\varphi \in \mathcal{M}_{p,q}(T_\Gamma)$ for any $p \in (0, q]$, and

$$\|\varphi\|_{\mathcal{M}_{p,q}(T_\Gamma)} \leq \frac{\gamma(n,p,q)}{(V_n(\Gamma))^{1/p-1}} \sigma^{n(1/p-1)} \|\widehat{\varphi}\|_q.$$

Here, $V_n(\Gamma)$ is the maximum volume of simplex that could be built on n unit vectors contained in $\overline{\Gamma}$.

For a non compactly supported φ , sufficient conditions related to its smoothness are obtained. It is shown that the *Bochner-Riesz Means* of the Fourier integral

$$R_h^{r,\alpha}(f; z) = \int_{|x| \leq 1/h} \widehat{f}(x) (1 - h^{2r}|x|^{2r})^\alpha e^{2\pi i(z,x)} dx, \quad z \in T_\Gamma,$$

define a Fourier multiplier from H^p to H^q if and only if $\alpha > n/q - (n+1)/2$.

A Bernstein type inequality, and an inequality for different p -th norms of entire functions of exponential type belonging to H^p , are also obtained. (Received January 10, 2012)

1081-42-77 **Paul Hagelstein*** (paul_hagelstein@baylor.edu), Department of Mathematics, Baylor University, P. O. Box 97328, Waco, TX 76798. *Transference of Weak Type Bounds of Multiparameter Ergodic and Geometric Maximal Operators*.

In this talk we will discuss recent work of Hagelstein and Stokolos regarding transference methods in multiparameter harmonic analysis and ergodic theory. Particular emphasis will be given on how these methods enable us to yield sharp weak type bounds on ergodic maximal operators associated to rare bases. (Received January 30, 2012)

- 1081-42-115 **Loukas Grafakos*** (grafakosl@missouri.edu), Department of Mathematics, University of Missouri, Columbia, MO 65201, and **Gerald Teschl** (Gerald.Teschl@univie.ac.at), Faculty of Mathematics, University of Vienna, Nordbergstr. 15, 1090 Vienna, Austria. *On Fourier transforms of radial functions and distributions.*

We find a formula that relates the Fourier transform of a radial function on \mathbf{R}^n with the Fourier transform of the same function defined on \mathbf{R}^{n+2} . This formula enables one to explicitly calculate the Fourier transform of any radial function $f(r)$ in any dimension, provided one knows the Fourier transform of the one-dimensional function $t \rightarrow f(|t|)$ and the two-dimensional function $(x_1, x_2) \rightarrow f(|(x_1, x_2)|)$. We prove analogous results for radial tempered distributions. (Received February 04, 2012)

- 1081-42-128 **Árpád Bényi, Frédéric Bernicot, Diego Maldonado** and **Virginia Naibo***, Kansas State University, Mathematics Department, 138 Cardwell Hall, Manhattan, KS 66506, and **Rodolfo Torres**. *On the Hörmander classes of bilinear pseudodifferential operators.* Preliminary report.

Boundedness properties for pseudodifferential operators with symbols in the bilinear Hörmander classes of sufficiently negative order are proved. The results are obtained in the scale of Lebesgue spaces and, in some cases, end-point estimates involving weak-type spaces and BMO are provided as well. From the Lebesgue space estimates, Sobolev ones are then easily obtained using functional calculus and interpolation. In addition, it is shown that, in contrast with the linear case, operators associated with symbols of order zero may fail to be bounded on products of Lebesgue spaces. (Received February 06, 2012)

- 1081-42-153 **Wilfredo O Urbina*** (wurbinaromero@roosevelt.edu), Dep. of Mathematics and Actuarial Sciences, 430 S Michigan Ave, Chicago, IL 60605, and **Eduard Navas** (enavas@unefm.edu.ve), Departamento de Matemáticas, Universidad, Experimental Francisco de Miranda, Coro, Falcon, Venezuela. *Transference method of the L^p continuity of the Littlewood-Paley-Jacobi g function to the to the Littlewood-Paley-Hermite and Littlewood-Paley-Laguerre g functions.* Preliminary report.

In this work we apply a transference method in order to obtain the L^p -continuity of the Littlewood-Paley-Hermite and Littlewood-Paley-Laguerre g functions from the L^p -continuity of the Littlewood-Paley-Jacobi g function using the well known asymptotic relations between Jacobi polynomials and Hermite and Laguerre polynomials. (Received February 08, 2012)

- 1081-42-196 **Spyridon Dendrinos** (spyridon.dendrinos@jyu.fi) and **Betsy Stovall*** (betsy@math.ucla.edu). *Uniform estimates for the X-ray transform restricted to polynomial curves.*

We outline a proof of near-optimal mixed-norm estimates for the X-ray transform restricted to polynomial curves with a weight that is a power of the affine arclength. The bounds that we establish depend only on the spatial dimension and the degree of the polynomial. (Received February 11, 2012)

- 1081-42-205 **Alex Stokolos*** (astokolos@georgiasouthern.edu), Department of Mathematics, Georgia Southern University, PO Box 8093, Statesboro, GA 30460. *On the Rate of $a.e.$ Convergence of Certain Classic Integral Means.*

We are going to present a nearly optimal results concerning the rate of almost everywhere convergence of the integral means defined in terms of the Fourier integrals multipliers. A typical result for these means is the following:

If the function f belongs to the Besov space $B_{p,p}^s$, $1 < p < \infty$, $0 < s < 1$, then $T_t f(x) - f(x) = o_x(t^s)$ a.e. as $t \rightarrow 0+$.

This is a joint work with Walter Trebels. (Received February 11, 2012)

- 1081-42-217 **James Michael Wilson*** (jmwilson@uvm.edu), 16 Colchester Avenue, Department of Mathematics, University of Vermont, Burlington, VT 05405. *Almost-orthogonality in weighted spaces.*

For $\alpha > 0$, let C_α be the uniformly (norm ≤ 1) α -Hölder continuous functions with supports contained in the unit ball of \mathbf{R}^d . Let $\{\phi^{(Q)}\} \subset C_\alpha$ be any family indexed over the dyadic cubes Q . If x_Q is the center of Q and $\ell(Q)$ is its sidelength, define

$$\phi_{z_Q}^{(Q)}(x) \equiv \phi^{(Q)}(2(x - x_Q)/\ell(Q)),$$

which is $\phi^{(Q)}$ translated and dilated (but not scaled) to the cube Q . We will show that if w is an A_∞ weight then the family $\{\phi_{z_Q}^{(Q)}/|Q|^{1/2}\}$ is almost-orthogonal in $L^2(dx)$ if and only if the family $\{\phi_{z_Q}^{(Q)}/w(Q)^{1/2}\}$ is almost-orthogonal in $L^2(w)$; where we say a family $\{\psi_k\}$ is almost-orthogonal in $L^2(\mu)$ if there is an $R < \infty$ such that,

for all finite linear sums $\sum \lambda_k \psi_k$,

$$\int |\sum \lambda_k \psi_k|^2 d\mu \leq R \sum |\lambda_k|^2.$$

If time permits we will say something about how this relates to stability of almost-orthogonal expansions. (Received February 12, 2012)

1081-42-278 **Carlos Perez*** (carlosperez@us.es), Facultad de Matemáticas, Universidad de Sevilla, C/ Tarfia s/n, 41080 Sevilla, Sevilla, Spain. *Sharp weighted estimates for maximal singular Calderón-Zygmund Singular Operators with no condition on the weight.*

In this talk we will present some recent results concerning maximal Calderón-Zygmund singular integral operator T^* and weights assuming no condition on the weight. To be more precise we will discuss the following fully optimal results

$$\|T^* f\|_{L^p(w)} \leq c_n p' \left(\frac{1}{\delta}\right)^{1/p'} \|f\|_{L^p(M_{L(\log L)^{p-1+\delta}}(w))} \quad p > 1, w \geq 0, \delta > 0.$$

and as consequence

$$\|T^* f\|_{L^{1,\infty}(w)} \leq c_n \frac{1}{\delta} \int_{\mathbb{R}^n} |f(x)| M_{L(\log L)^\delta}(w)(x) dx \quad \delta > 0, w \geq 0$$

Last estimate yields a quantitative version of the so called two weight bump $L \log L$ bump condition. Also this second estimate is related to the failure of the so called Muckenhoupt-Wheeden conjecture disproved by M. Reguera and C. Thiele. These results were obtained in the 90's by the speaker just for the linear operator T in a less quantitative way. One of the difficulties is that the operator now is not linear.

These results have been obtained jointly with T. Hytönen. (Received February 14, 2012)

1081-42-282 **Dmitriy Bilyk*** (bilyk@math.sc.edu), 1523 Greene St, Dept of Mathematics, Columbia, SC 29208. *Fourier analysis and uniform distribution.*

We shall discuss the application of harmonic analysis techniques to constructions of various well-distributed sets. (Received February 13, 2012)

1081-42-312 **Vjekoslav Kovac** and **Christoph Thiele*** (thiele@math.ucla.edu). *A twisted $T(1)$ theorem.* Preliminary report.

We discuss the twisted paraproduct of the first author and progress towards a $T(1)$ theorem related to this twisted paraproduct. (Received February 13, 2012)

1081-42-313 **Michael T. Lacey** (Lacey@math.gatech.edu), School of Mathematics, Georgia Institute of Technology, Atlanta, GA 30332, **Eric T. Sawyer** (sawyer@mcmaster.ca), Dept. of Mathematics & Statistics, McMaster University, 1280 Main Street West, Hamilton, Ontario L8S 4K1, Canada, **Chun-Yen Shen** (cyshen@math.mcmaster.ca), Dept. of Mathematics & Statistics, McMaster University, 1280 Main Street West, Hamilton, Ontario L8S 4K1, Canada, and **Ignacio Uriarte-Tuero*** (ignacio@math.msu.edu), Department of Mathematics, Michigan State University, East Lansing, MI 48824. *Two Weight Inequality for the Hilbert Transform: A Real Variable Characterization.*

The two weight inequality for the Hilbert transform arises in the settings of analytic function spaces, operator theory, and spectral theory, and what would be most useful is a characterization in the simplest real-variable terms. We show that the L^2 to L^2 inequality holds if and only if two L^2 to weak- L^2 inequalities hold. This is a corollary to a characterization in terms of a two-weight Poisson inequality, and a pair of testing inequalities on bounded functions. (Received February 13, 2012)

1081-42-320 **Ciprian Demeter*** (demeterc@indiana.edu). *Two problems in Harmonic Analysis.*

I will discuss two distinct problems. One concerns optimal bounds for the directional Hilbert transform in the plane. The other one is the boundedness of the tensor product between the bilinear Hilbert transform and a paraproduct. (Received February 13, 2012)

1081-42-403 **A Magyar*** (magyar@math.ubc.ca) and **T Titichetrakun** (tatchai@math.ubc.ca). *3-point configurations in dense subsets of P^2 .*

Let A be subset of P^2 (the set of prime tuples) of positive upper relative density. We show that A contains infinitely many affine copies of any 3-point configuration. The method is based on an application of the so-called relative triangle removal lemma in graph theory. Joint work with T. Titichetrakun. (Received February 15, 2012)

43 ► *Abstract harmonic analysis*

1081-43-234 **Oleksandra V Beznosova*** (alexbeznosova@yahoo.com). *Equivalent definitions of Muckenhoupt and Reverse Holder classes of weights via summation conditions.*

We look at the summation conditions of the Buckley type for the Reverse Holder and Muckenhoupt weights and deduce them from an intrinsic lemma which gives a summation representation of the bumped average of a weight. We also obtain summation conditions for continuous Reverse Holder and Muckenhoupt classes and both continuous and dyadic weak Reverse Holder classes. We also show that the constant in each summation inequality of Buckley's type is comparable to the corresponding Muckenhoupt or Reverse Holder constant. To prove our results we use the Bellman function method. (Received February 13, 2012)

1081-43-310 **Jonathan W. Poelhuis*** (jpoelhui@indiana.edu), Department of Mathematics, Indiana University, 831 E. Third St., Bloomington, IN 47405. *Local Fractional Maximal Operators.* Preliminary report.

Fractional maximal operators arise in the study of Riesz potentials and are discussed in the work of Hedberg (1972) and others. These operators have interesting properties that are distinct from those of the Hardy-Littlewood maximal operator, which they resemble. In another direction, many results have followed Stromberg's (1979) paper discussing local maximal operators. Local operators in this sense have the advantage that they are defined for measurable functions, not just integrable ones. We define local analogues for the fractional maximal operators and discuss several of their properties, including a John-Nirenberg type inequality. (Received February 13, 2012)

46 ► *Functional analysis*

1081-46-9 **Alexander A. Katz*** (katza@stjohns.edu), St. John's University, Dep. of Math & CS, 300 Howard Avenue, DaSilva Academic Center 314, Staten Island, NY 10301. *A note on automatic continuity of Jordan *-homomorphisms for locally JB*-algebras.*

Recently we have introduced the locally JB*-algebra (sigma-JB*-algebra) as a projective limit of the (countably large) projective family of JB*-algebras. In the present note we show that any Jordan *-homomorphism from any sigma-JB*-algebra to an arbitrary locally JB*-algebra is automatically continuous. (Received October 01, 2011)

1081-46-21 **Alexander A. Katz** (katza@stjohns.edu), St. John's University, Dep. of Math & CS, 300 Howard Avenue, DaSilva Academic Center 314, Staten Island, NY 10301, and **Roman Kushnir*** (kushnir_roman@yahoo.com), UNISA, Pretoria, RSA, Dep. of Math. Sciences, and St. John's University, Dep of Math & CS, 8000 Utopia Parkway, SJH 334, Queens, NY 11439. *On the Gelfand-Mazur type theorem for C*-algebras over $C_\infty(Q, C)$, where Q is a Stonean compact.*

In the sequel we show that any Banach-Kantorovich C*-algebra over $C_\infty(Q, C)$, where Q is a Stonean compact, in which every element with the unit support is invertible is isometrically *-isomorphic to the algebra $C_\infty(Q, C)$, where is a Stonean compact. (Received December 19, 2011)

1081-46-295 **Zhijian Wu*** (zwu@as.ua.edu), Department of Mathematics, The University of Alabama, Tuscaloosa, AL 35487. *On the distances from Lipschitz functions to Morrey spaces.* Preliminary report.

In this talk, we establish several approaches to characterize the distance from a function in Lipschitz spaces to Morrey spaces. Our results generalize an early result of Peter Jones about the distance from a Bloch function to BMOA. (Received February 13, 2012)

47 ► *Operator theory*

1081-47-244 **Michael A Gilliam*** (gilliam.m.a@gmail.com), 25 Lee Court, New Rochelle, NY 10805, and **Jennifer Halfpap**, University of Montana. *The Szegő Kernel for Certain Non-pseudoconvex Domains in C^2 .*

The Szegő projection operator associated with a domain Ω in C^n with smooth boundary is of fundamental interest in complex analysis. Its action can often be expressed as integration against a distribution, known as the Szegő kernel, on $\partial\Omega \times \partial\Omega$, which is equal to a smooth function off some exceptional set. Understanding the

relative structure of this set and obtaining sharp size estimates of the kernel for points near this set is essential for understanding the mapping properties of the operator. There are many results of this nature for pseudoconvex domains of finite type, where the exceptional set is precisely the diagonal of $\partial\Omega \times \partial\Omega$. Comparatively little is known for non-pseudoconvex domains. We discuss the latter for a subclass of tubular domains in \mathbb{C}^2 and show, in particular, that the exceptional set contains points on *and off* of the diagonal. (Received February 13, 2012)

51 ► Geometry

1081-51-103 **Weiwei Wu*** (wuxxx347@umn.edu), 127 Vincent Hall, 206 Church Street, Minneapolis, MN 55455. *On Lagrangian semi-toric singularities.*

We consider non-displaceable Lagrangian torus fibers in some semi-toric systems. In particular, we prove that these fibers are superheavy with respect to certain symplectic quasi-state. In particular, this implies that Lagrangian RP^2 is not a stem in CP^2 , answering a question of Entov and Polterovich. (Received February 03, 2012)

1081-51-148 **Garrett Alston*** (galston@math.ksu.edu). *Real Lagrangians in the quintic and matrix factorizations.*

I will talk about matrix factorizations that are thought to be mirror to the real Lagrangians in the quintic. I hope to give some evidence of this correspondence. (Received February 08, 2012)

1081-51-226 **Roman M Fedorov*** (fedorov@math.ksu.edu), 138 Cardwell Hall, Mathematics Department, Kansas State University, Manhattan, KS 66502. *Irregular Knizhnik-Zamolodchikov-Bernard systems and the Casimir connection.*

I shall recall the notion of KZB connection on spaces of conformal blocks over moduli of curves with marked points. Then I shall introduce their irregular generalizations. The latter corresponds to non-highest weight representations of Kac-Moody algebras. I will show that some new directions arise in the irregular case and identify them in the simplest case with the Casimir connection on the regular part of a Cartan subalgebra of the corresponding finite-dimensional Lie algebra.

Time permits, I shall explain that the irregular KZB connection is a deformation of the irregular isomonodromic system. (Received February 12, 2012)

1081-51-291 **Ailsa M Keating*** (ailsa@math.mit.edu), M.I.T. Mathematics Department, 2-588, 77 Mass. Ave., Cambridge, MA 02139. *Dehn twists and free subgroups of the symplectic mapping class group.*

Given two Lagrangian spheres in an exact symplectic manifold, we present conditions under which the Dehn twists about them generate a free non-abelian subgroup of the symplectic mapping class group. This extends a result of Ishida for Riemann surfaces. The proof generalises the categorical version of Seidel's long exact sequence to arbitrary powers of a fixed Dehn twist. (Received February 13, 2012)

1081-51-309 **Jing Tao*** (jing@math.utah.edu). *Geometry of the Lipschitz metric on Teichmüller space.* First introduced by Thurston, the Lipschitz metric is an asymmetric metric on Teichmüller space, which is defined in terms of the best Lipschitz map between two hyperbolic surfaces. The purpose of this talk will be to highlight some aspects of this metric which make it resemble a metric of negative curvature. (Received February 13, 2012)

52 ► Convex and discrete geometry

1081-52-15 **Dmitry Ryabogin*** (ryabogin@math.kent.edu), 122 Chesterton Ln, Aurora, OH 44202. *Non-uniqueness of convex bodies with prescribed volumes of sections and projections.* Preliminary report.

This is the joint work with Fedor Nazarov and Artem Zvavitch. We show that in all dimensions $d \geq 3$, there exists an asymmetric convex body all of whose maximal hyperplane sections have the same volume. This gives the negative answer to the question posed by Klee in 1969. We also show that if $d \geq 4$ is even, then one can find two essentially different convex bodies such that the volumes of their maximal sections, central sections, and projections coincide for all directions. (Received November 17, 2011)

53 ► Differential geometry

1081-53-26 **Chanyoung Jun*** (cyjun2@gmail.com), 1409 W. Green Street, Urbana, IL 61801.
Pursuit-evasion and time-dependent gradient flow in singular spaces.

Pursuit-evasion games are generated from robotics, control theory and computer simulations. CAT(0) and CAT(K) spaces are suitable playing fields, and vastly generalize the usual playing fields in the pursuit-evasion literature. On these spaces, we prove existence and uniqueness theorems for pursuit curves, as well as convergence estimates and a regularity theorem. Recently, time-independent gradient flow has been studied extensively in CAT(0) spaces. Pursuit curves are downward gradient curves for the distance from a moving evader, that is, for a time-dependent gradient flow. We extend our results to more general time-dependent gradient flow in CAT(0) spaces. (Received December 20, 2011)

1081-53-171 **Lino Amorim*** (amorim@math.wisc.edu). *A Kunnet theorem in Lagrangian Floer theory.* Fukaya, Oh, Ohta and Ono associate to each compact Lagrangian submanifold a filtered A-infinity algebra. In this talk, I will describe a Kunnet theorem for this algebra. I will first discuss the tensor product of A-infinity algebras. Then I will show that the A-infinity algebra of a product of two Lagrangians is quasi-isomorphic to the tensor product of the algebras of the factors. In the end, I will discuss possible generalizations of this result. (Received February 09, 2012)

1081-53-175 **Subhojoy Gupta*** (subhojoy.gupta@yale.edu), 10 Hillhouse Avenue, New Haven, CT 06511. *Asymptoticity of grafting and Teichmüller rays.*

We shall discuss a result showing that any grafting ray in Teichmüller space determined by an arational lamination or a multi-curve is (strongly) asymptotic to a Teichmüller geodesic ray. Our method involves constructing quasiconformal maps between the underlying Thurston metric of a complex projective surface on one hand, and the singular flat metric induced by a holomorphic quadratic differential on the other. As a consequence we can show that the set of points in Teichmüller space obtained by integer graftings on any hyperbolic surface projects to a dense set in moduli space. (Received February 09, 2012)

1081-53-178 **Dmitri Scheglov*** (dvs117@gmail.com), 303 H, Norman, OK 73072. *Canonical metrics in a conformal class.* Preliminary report.

We construct a new functional on the space of metrics on any smooth $2n$ manifold. And for this functional we prove existence and uniqueness of the minimizing metrics by surprisingly simple methods. (Received February 09, 2012)

1081-53-201 **Gabriel D Kerr*** (gdkerr@math.miami.edu). *Degenerations of LG models and relations in symplectomorphism groups.*

In this talk I will detail a class of relations occurring in symplectomorphism groups of higher dimensional symplectic manifolds. These turn out to be generalizations of well known mapping class group relations in dimension 2 such as the lantern and star relations. The group elements occurring in these relations arise as symplectic monodromy around either a toric degeneration or a stratified Morse function. I will describe the symplectic geometry of these transformations for the different cases. In the second part of the talk I will explain a definition of the complex moduli \mathcal{M}_{LG} of LG models on a toric variety. The boundary $\partial\mathcal{M}_{LG}$ has points which correspond to maximally degenerated LG models. Every maximal degeneration decomposes into a sequence of partial LG models, each of which is directly associated to one of the relations above. Such sequences will then be conjectured to be the A-model mirror of the (toric) Mori and Sarkisov programs in birational geometry. (Received February 11, 2012)

1081-53-203 **Sheel C. Ganatra*** (ganatra@math.mit.edu). *On the Hochschild (co)homology of the Fukaya Category.* Preliminary report.

Let M be an exact symplectic manifold. We prove that if M has enough Lagrangians, then the symplectic cohomology of M is isomorphic to both the Hochschild homology and cohomology of M 's wrapped Fukaya category. Some ingredients in the proof are: Fourier-Mukai theory for the wrapped Fukaya category via holomorphic quilts, a version of the Cardy condition, and a new self-duality for the wrapped Fukaya category (a non-compact version of the Calabi-Yau condition). (Received February 11, 2012)

1081-53-365 **David Dumas*** (ddumas@math.uic.edu) and **Michael Wolf**. *Convex real projective structures, polynomials, and polygons*. Preliminary report.

The holonomy representations of convex real projective structures on a compact surface form a connected component of the variety of $SL(3, \mathbb{R})$ -representations of the fundamental group. Labourie and Loftin used differential-geometric invariants of affine spheres to parameterize this space using holomorphic data—a Riemann surface and a holomorphic cubic differential. We describe a program to understand the geometric limits of real projective structures in this parameterization by considering a class of affine spheres which are conformally equivalent to the complex plane. Our results include progress toward an identification between a space of affine spheres with polynomial cubic differentials and the moduli space of convex polygons in the real projective plane. (Received February 14, 2012)

54 ► *General topology*

1081-54-70 **Aaron Kaestner*** (akaestne@gmail.com) and **Louis H Kauffman**. *Parity Biquandles*.

We use crossing parity to construct a generalization of biquandles for virtual knots which we call Parity Biquandles. These structures include all biquandles as a standard example referred to as the even parity biquandle. Additionally, we find all Parity Biquandles arising from the Alexander Biquandle and Quaternionic Biquandles and discuss some related results. (Received January 28, 2012)

1081-54-256 **Lena Folwaczny*** (lfolwa2@uic.edu). *Finite-Type Invariants of Classical and Virtual Knots*. Preliminary report.

This talk introduces finite type invariants (Vassiliev invariants) for knots and explores their connection with other knot invariants and their Lie Algebraic structure. Many examples of finite type invariants for classical knots do not extend to virtual knots. We will talk about the progress in the area of virtual finite type invariants. (Received February 14, 2012)

55 ► *Algebraic topology*

1081-55-7 **Micah W. Chrisman*** (mchrisma@monmouth.edu). *On the Combinatorics of Smoothing*.

Many virtual knot invariants have their values determined by a choice of smoothing on a subset of the classical crossings. From the smoothing, one typically needs to count the number of connected components obtained. We present an efficient method to count the the number of these connected components. The method is based upon an application of spectral graph theory to a modification of a theorem of Zulli. We apply this method to counting one component subdiagrams of the family of pretzel knots. Two different classes of smoothings are considered. (Received September 14, 2011)

1081-55-361 **Gregory T Mezera*** (gtm@gwu.edu). *Every group is a distributive set in a monoid of binary operations*.

Abstract.

Let X be a set and $Bin(X)$ the set of all distributive operations on X . We say that $S \subset Bin(X)$ is a distributive set of operations if all pairs of elements $*_{\alpha}, *_{\beta} \in S$ are right distributive, that is, $(a *_{\alpha} b) *_{\beta} c = (a *_{\beta} c) *_{\alpha} (b *_{\beta} c)$ (we allow $*_{\alpha} = *_{\beta}$).

J.Przytycki raised the question of which groups can be realized as distributive sets. The initial guess that we may embed any group G into $Bin(X)$ for some X was brought into question after making an observation that if $* \in S$ is idempotent ($a * a = a$), then $*$ commutes with every element of S . The first noncommutative subgroup of $Bin(X)$ (the group S_3) was found computationally in October of 2011 by Y.Berman.

Here we show that any group can be embedded in $Bin(X)$ for $X = G$ (as a set). We also discuss (representation theoretic) criteria for minimal embeddings, and give an example where X has six elements and $Bin(X)$ contains a non-abelian subgroup. (Received February 14, 2012)

57 ► *Manifolds and cell complexes*

1081-57-2 **Benson Farb, Christopher J Leininger*** (clein@math.uiuc.edu) and **Dan Margalit**.
Complexity of surface homeomorphisms.

Thurston classified homeomorphisms of surfaces, up to isotopy, into three types. This is modeled on what happens for the torus in which every isotopy class is represented by a 2×2 integral matrix, and is either hyperbolic, parabolic, or elliptic. For the torus, the richest structure occurs for a hyperbolic matrix which gives rise to an *Anosov diffeomorphism* of the torus. The analogue on an arbitrary surface is a *pseudo-Anosov homeomorphism*.

I will begin by explaining what a pseudo-Anosov homeomorphism is through examples. I will also describe the basic measure of complexity for a pseudo-Anosov homeomorphism called its *dilatation*, and explain geometric, dynamic, and analytic interpretations of it. Then I will explain the motivating problem of finding the least complex pseudo-Anosov homeomorphisms. The last half of the talk will describe my work with Farb and Margalit on this problem which has found interesting connections with topology, algebra and geometry. (Received February 12, 2012)

1081-57-6 **Charles Frohman*** (charles-frohman@uiowa.edu), **Michael Fitzpatrick** (Michael-C-Fitzpatrick@uiowa.edu) and **Joanna Kania-Brtoszynska** (jkaniab@nsf.gov). *Projective Representations of Mapping Classes of Surfaces coming from the Kauffman bracket.*

We will discuss the ensemble of projective representations of the mapping class group of a surface with boundary coming from the extended TQFT underlying the Kauffman bracket. (Received August 08, 2011)

1081-57-40 **Anh T Tran*** (tran@math.gatech.edu), School of Mathematics, Georgia Institute of Technology, 686 Cherry ST, Atlanta, GA 30332. *Proof of a stronger version of the AJ conjecture for torus knots.*

For a knot K in S^3 , the sl_2 -colored Jones function $J_K(n)$ is a sequence of Laurent polynomials in the variable t , which is known to satisfy non-trivial linear recurrence relations. The operator corresponding to the minimal linear recurrence relation is called the recurrence polynomial of K . The AJ conjecture of Garoufalidis states that when reducing $t = -1$, the recurrence polynomial is essentially equal to the A-polynomial of K . In this talk we consider a stronger version of the AJ conjecture, proposed by Sikora, and confirm it for all torus knots. (Received January 14, 2012)

1081-57-51 **Heather M. Russell*** (heathemr@usc.edu), **Matthew Housley** and **Julianna S. Tymoczko**. *Symmetric group actions on webs.* Preliminary report.

By specializing the q parameter in the sl_2 and sl_3 spider categories, we obtain a symmetric group action on a certain subcollection of webs. This action is known to be irreducible, but the relationship between the web basis and other bases for symmetric group representations is not well understood. Using an explicit bijection between Young tableaux and webs, we will discuss various features of the web basis. (Received January 18, 2012)

1081-57-54 **Allison Henrich***, 901 12th Ave, Seattle, WA 98122, and **Tom Boothby** and **Alexander Leaf**. *Minimal Diagrams of Free Knots.*

Recently, Manturov introduced a generalization of virtual knots and strings called free knots. There are several ways of finding minimal crossing diagrams of free knots, particularly using graphs that have the property of being irreducibly odd. We will investigate the structure of irreducibly odd and other families of graphs that produce minimal diagrams of free knots. (Received January 20, 2012)

1081-57-56 **Heather A Dye*** (hadye@mckendree.edu), **Louis Kauffman** (kauffman@uic.edu) and **Allison Henrich** (henricha@seattleu.edu). *Generalized Parity.*

Generalized Parity is a mapping from the crossings of a virtual knot to the elements of a group. Using the parity of the crossings, we construct families of invariants of virtual knots. (Received January 21, 2012)

1081-57-64 **Robert Todd*** (rtodd@unomaha.edu). *Computing 4-move invariants.* Preliminary report.

Nakanishi conjectured that every knot can be reduced to the trivial knot via 4-moves. Here we investigate a 4-move invariant defined by Dabkowski and Sahi. We use extensive computer calculations show that this invariant is trivial for most (and possible all) alternating knots with 18 crossings or less. (Received January 24, 2012)

1081-57-75 **Moshe Cohen** and **Adam Lowrance*** (adam-lowrance@uiowa.edu), Department of Mathematics, 14 MacLean Hall, University of Iowa, Iowa City, IA 52242. *A categorification of the Tutte polynomial*. Preliminary report.

We construct a categorification of the Tutte polynomial for graphs and matroids. Our categorification is a triply graded vector space whose graded Euler characteristic is the Tutte polynomial. We discuss generalizations of the deletion-contraction and duality formulas for the Tutte polynomial. We also show how to obtain an invariant of alternating knots and discuss a possible relationship with Khovanov homology. (Received January 30, 2012)

1081-57-79 **Sam Nelson***, 850 Columbia Ave, Claremont, CA 91711. *Quantum Enhancements of Involutory Rack Counting Invariants*. Preliminary report.

The involutory rack counting invariant is an integer-valued invariant of unoriented links. We enhance this invariant with quantum weights which may be understood as customized Reshetikhin–Turaev invariants of rack-labeled links. (Received January 31, 2012)

1081-57-92 **Carmen Caprau***, Department of Mathematics, 5245 N. Backer Ave. M/S PB108, Fresno, CA 93740. *An invariant for handlebody-tangles*. Preliminary report.

A handlebody-tangle is a disjoint union of handlebodies embedded in the 3-ball B^3 , such that the intersection of the handlebodies with ∂B^3 consists of disks (called end disks). Two handlebody-tangles are equivalent if one can be transformed into the other by an isotopy of B^3 which fixes ∂B^3 . A handlebody-link can be regarded as a handlebody-tangle with no end disks.

We use the Kauffman bracket to construct a numerical invariant for handlebody-tangles/links. (Received February 02, 2012)

1081-57-112 **Lenhard Ng** and **Dan Rutherford*** (drrutherford@uark.edu). *Satellites of Legendrian knots and representations of the Chekanov-Eliashberg algebra*. Preliminary report.

In the late 1990's, Chekanov and Eliashberg introduced a differential graded algebra (DGA) associated to a Legendrian knot L in \mathbb{R}^3 . There is a well-known correspondence (due to Fuchs-Ishkanov and Sabloff) between augmentations of this DGA and normal rulings of the front projection of L . We generalize this to a correspondence between certain normal rulings of satellites of L and finite-dimensional representations of its DGA. We derive some consequences by exploiting relationships between normal rulings and the Kauffman and HOMFLY-PT knot polynomials. In particular, we are able to show that the existence of (ungraded) representations of any particular dimension depends only on the underlying framed knot type of L . (Received February 04, 2012)

1081-57-176 **Masahico Saito*** (saito@usf.edu), **W. Edwin Clark**, **Mohamed Elhamdadi**, **Xiang-dong Hou** and **Timothy Yeatman**. *On a family of extension quandles associated with pointed abelian groups*.

A family of quandles are constructed as extensions of the 3-element dihedral quandle by pointed abelian groups. They are classified by isomorphism classes of pointed abelian groups, and identified with some of the quandles in the table of small connected quandles. Colorings of knots and virtual knots by these quandles are discussed. (Received February 09, 2012)

1081-57-181 **Rasimate Maungchang*** (rmaungc2@uiuc.edu). *The Sunada construction and the simple length spectrum*.

We show that certain families of iso-length spectral hyperbolic surfaces obtained via the Sunada construction are not generally simple iso-length spectral. (Received February 10, 2012)

1081-57-189 **Jonathan Schneider*** (jschne9@uic.edu). *Virtual 2-knots and 2-links*.

A “virtual 2-knot or 2-link” is, formally, a generic surface in R^3 with each self-intersection arc labeled “over”, “under”, or “virtual”, modulo the “virtual Roseman moves”. We define this category in detail and give examples. (Received February 10, 2012)

1081-57-191 **Patricia Cahn*** (patricia.cahn@dartmouth.edu) and **Asa Levi**. *Vassiliev Invariants of Virtual Legendrian Knots*. Preliminary report.

We introduce virtual Legendrian knots. We then construct an isomorphism between the groups of Vassiliev invariants of virtual Legendrian knots and of virtual framed knots in the total space of the spherical cotangent bundle of a surface. This builds on results of Fuchs-Tabachnikov, Goryunov, Hill and Chernov about isomorphisms of groups of Vassiliev invariants of (nonvirtual) Legendrian and topological knots. (Received February 10, 2012)

1081-57-207 **Eric Zaslow*** (zaslow@math.northwestern.edu), 2033 Sheridan Road, Evanston, IL 60208.
Polytopes and Skeleta.

I will discuss the relation of constructible sheaves to mirror symmetry at the large complex and large radius limits. This involves creating a conjectural skeleton for affine Calabi-Yau hypersurfaces and building a category from it. I will compare these skeleta with similar constructions from tropical geometry. (Received February 11, 2012)

1081-57-209 **Alissa Crans and Jozef H. Przytycki*** (przytyck@gwu.edu), Department of Mathematics, George Washington University, Washington, DC 20052, and **Krzysztof Putyra.** *Torsion in one term distributive homology.* Preliminary report.

Let $(X; *)$ be a shelf, that is a magma with a right self-distributive operation $((a * b) * c = (a * c) * (b * c))$. We consider (one-term) distributive homology with a chain complex $C_n(X) = ZX^{n+1}$ and the boundary operation given by $\partial(x_0, x_1, \dots, x_n) = (x_1, \dots, x_n) + \sum_{i=1}^n (-1)^i (x_0 * x_i, \dots, x_{i-1} * x_i, x_{i+1}, \dots, x_n)$. It was conjectured that such homology $H_k^{(*)}(X)$ is always torsion free (for a rack it is known to be acyclic). We show here the opposite, the homology is reach in torsion. For example, we define $(X_{n,k}; *)$, $k < n$ with $X_{n,k} = \{1, 2, \dots, n\}$ and $i * j = j$ for $i, j < n$ or $j = n$, furthermore $n * i = i + 1$ for $i < k < n$, and $n * i = 1$ for $k \leq i < n$, then, $H_1^{(*)}(X_{n,k}) = Z^2 \oplus Z_k^{n-k-1}$. This holds also for infinite n , producing infinite torsion. It is still an open problem whether left-connected $(H_0(X) = Z)$ shelves can have torsion in homology. (Received February 11, 2012)

1081-57-225 **David Futер*** (dfuter@temple.edu) and **Saul Schleimer.** *Cusp geometry of fibered 3-manifolds.*

Let F be a surface with punctures, and suppose that $\varphi : F \rightarrow F$ is a pseudo-Anosov homeomorphism fixing a puncture p of F . Then the mapping torus of φ is a hyperbolic 3-manifold M_φ , which contains a maximal cusp C corresponding to the puncture p . We show that the geometry of the maximal cusp C can be predicted, up to explicit multiplicative error, by the action of φ on the complex of essential arcs of in the surface F , denoted $A(F)$.

This result is motivated by an analogous theorem of Brock, which predicts the volume of M_φ in terms of the action of φ on the pants graph $P(F)$. However, in contrast with Brock's theorem. our result gives effective estimates, and is proved using completely elementary methods. This is joint work with Saul Schleimer. (Received February 12, 2012)

1081-57-339 **David Ben McReynolds*** (dmcreyno@math.purdue.edu), West Lafayette, IN 47906, and **Alan Reid and Matthew Stover.** *Collisions at infinity.*

A noncompact finite volume totally geodesic submanifold of a noncompact manifold can have cusp ends that collide in the cusp ends of the ambient manifold. I will discuss how this can happen, how one resolves this in covers, and a homological application. (Received February 14, 2012)

1081-57-360 **David A Clark*** (davidclark@rnc.edu), **Scott Morrison** and **Kevin Walker.** *Khovanov homology for knotted webs.* Preliminary report.

We aim to extend $\mathfrak{sl}(2)$ Khovanov homology to an invariant of knotted trivalent graphs, which is functorial with respect to piecewise-oriented singular cobordisms. One nice consequence would be a "naturality" statement for the exact triangle in Khovanov homology. (Received February 14, 2012)

1081-57-366 **Hossein Namazi*** (hossein@math.utexas.edu), 1 University Station C1200, Austin, TX 78712. *Combinatorics of hyperbolic structures on 3-manifolds.*

We will discuss and present a number of results that provide combinatorial pictures of hyperbolic structures on handlebodies and also of hyperbolic structures on manifolds obtained from gluings of smaller 3-manifolds. (Received February 14, 2012)

1081-57-401 **Alexander N. Shumakovitch*** (Shurik@gwu.edu), The George Washington University, Department of Mathematics, Monroe Hall, 2115 G St. NW, room 240, Washington, DC 20052. *On torsion in the Khovanov homology of knots.* Preliminary report.

We discuss properties and applications of torsion in the Khovanov homology of certain classes of knots and links. (Received February 14, 2012)

58 ► *Global analysis, analysis on manifolds*

1081-58-99 **Kenji Fukaya** (fukaya@math.kyoto-u.ac.jp), , Japan, **Yong-Geun Oh*** (oh@math.wisc.edu), Department of Mathematics, University of Wisconsin, 480 Lincoln Drive, Madison, WI 53706, **Hiroshi Ohta** (ohta@math.nagoya-u.ac.jp), , Japan, and **Kaoru Ono** (ono@math.sci.kokudai.ac.jp), , Japan. *Toric degeneration and non-displaceable Lagrangian tori in $S^2 \times S^2$.*

In this talk, using the idea of toric degeneration and the computation of the full potential function of the Hirzbruch surface F_2 , which is not Fano, we produce a continuum of Lagrangian tori in $S^2 \times S^2$ which are non-displaceable under the Hamiltonian isotopy. This talk is based on a joint work with Fukaya, Ohta and Ono. (Received February 02, 2012)

1081-58-393 **Raymond T Walter*** (rwalter@uark.edu), PO Box 160, Clarkridge, AR 72623. *A Clifford Algebraic Approach to Moebius Transformations and Liouville's Theorem.* Preliminary report.

In elementary complex analysis one considers conformal mappings, those functions that preserve the measure and orientation of angles. Among the various conformal mappings in the complex plane are Moebius transformations. These transformations demonstrate such important properties as forming a group under function composition, mapping generalized circles to generalized circles, and forming an automorphism group of the Riemann sphere, the last of which has relevance in relativistic physics. By a famous theorem of Liouville, in Euclidean space of dimension greater than two the only conformal mappings are Moebius transformations. We will briefly review classical proofs of this result before presenting an alternative proof grounded in Clifford algebras. This is part of a more general result in pseudo-Euclidean space due to Jan Cnops in An Introduction to Dirac Operators on Manifolds. We include the exposition of this theorem and its proof in a more general scheme of characterizing Moebius transformations using Clifford algebras, first developed by Vahlen in 1902 and revisited by Ahlfors late in his career. This will require us to briefly review the relevant aspects of Clifford algebras before proceeding to the proof of Liouville's Theorem. (Received February 14, 2012)

60 ► *Probability theory and stochastic processes*

1081-60-48 **Tadahiro (Choonghong) Oh***, Department of Mathematics, Fine Hall, Washington Rd, Princeton, NJ 08544-1000, and **Jeremy Quastel** and **Benedek Valko**. *Interpolation of Gibbs measures with white Noise for Hamiltonian PDEs.*

We consider a family of interpolation measures between Gibbs measures, corresponding to certain Hamiltonian PDEs (KdV, mKdV, and cubic NLS), and the white noise on the circle. We show that they converge weakly to the white noise. In particular, this implies (i) invariance of the white noise for KdV and (ii) the white noise is a weak limit of invariant measures for mKdV and cubic NLS. The proof is based on multilinear analysis of functions with random Fourier coefficients.

This is a joint work with Jeremy Quastel (Univ. of Toronto) and Benedek Valko (Univ. of Wisconsin Madison.) (Received January 17, 2012)

1081-60-60 **Lawrence Christopher Evans*** (evanslc@missouri.edu), 120 South Tenth Street (Apt 102), Columbia, MO 65201. *An approximation scheme for reflected stochastic differential equations.*

In a series of famous papers E. Wong and M. Zakai showed that the solution to a Stratonovich SDE is the limit of the solutions to a corresponding ODE driven by the piecewise-linear interpolation of the driving Brownian motion. In particular, this implies that solutions to Stratonovich SDE “behave geometrically as we would expect from ODE theory”. D. Stroock and I have shown that a similar approximation result holds, in the sense of weak convergence of distributions, for reflected Stratonovich SDE. We have also shown how this result can be used to give intuitive proofs of geometric properties of coupled reflected Brownian motion, especially those properties which have been used in recent work on the “hot spots” conjecture for special domains. (Received January 23, 2012)

1081-60-62 **Fabrice Baudoin*** (fbaudoin@purdue.edu), 150 N. University Street, West Lafayette, IN 47906, and **Xuejing Zhang**. *Taylor expansion for the solution of a stochastic differential equation driven by fractional Brownian motions.*

We study the Taylor expansion for the solution of a differential equation driven by a multi-dimensional Hölder path with exponent $\beta > 1/2$. We derive a convergence criterion that enables us to write the solution as an infinite

sum of iterated integrals on a nonempty interval. We apply our deterministic results to stochastic differential equations driven by fractional Brownian motions with Hurst parameter $H > 1/2$.

This is a joint work with Xuejing Zhang. (Received January 24, 2012)

1081-60-82 **Jie Xiong*** (jxiong@math.utk.edu), 227 Ayres Hall, 1403 Circle Drive, Knoxville, TN 37996-1320. *Well-posedness of the martingale problem for superprocess with interaction.*

We consider the martingale problem for the continuous state branching process with interactive motion, branching and immigration. The uniqueness of the solution to its martingale problem is established using the strong uniqueness of the solution to a corresponding SPDE. The later is obtained by an extended Yamada-Watanabe argument. This talk is based on a joint paper with Mytnik. (Received January 31, 2012)

1081-60-95 **Yaoyong Hu, David Nualart and Fangjun Xu*** (fxu@math.ku.edu), Department of Mathematics, University of Kansas, Lawrence, KS 66045. *Central limit theorem for an additive functional of the fractional Brownian motion.*

We prove a central limit theorem for an additive functional of the d -dimensional fractional Brownian motion with Hurst index $H \in (\frac{1}{1+d}, \frac{1}{d})$, using the method of moments, extending the result by Papanicolaou, Stroock and Varadhan in the case of the standard Brownian motion. (Received February 02, 2012)

1081-60-123 **Boris Rozovsky*** (boris_rozovsky@brown.edu). *Generalized Malliavin Calculus and Stochastic PDEs.*

Extension of the main operators of Malliavin calculus from Brownian motion to nonlinear generalized functionals of white noise will be discussed. These results will be applied to investigation of new classes of stochastic PDEs. (Received February 06, 2012)

1081-60-131 **Rami Atar and Amarjit Budhiraja*** (budhiraj@email.unc.edu), 357 Hanes Hall, CB# 3260, Chapel Hill, NC 27599. *A Stochastic Differential Game for the Infinity Laplacian.*

A two-player zero-sum stochastic differential game, defined in terms of an m -dimensional state process that is driven by a one-dimensional Brownian motion, played until the state exits the domain, is studied. The players controls enter in a diffusion coefficient and in an unbounded drift coefficient of the state process. We show that the game has value, and characterize the value function as the unique viscosity solution of an inhomogeneous infinity Laplace equation. (Received February 07, 2012)

1081-60-152 **ARKA P GHOSH*** (apghosh@iastate.edu), 3216 Snedecor Hall, Iowa State University, AMES, IA 50014. *Optimal rate for a queueing system in heavy traffic with superimposed On-Off arrivals.*

We consider a queueing control problem with a system with heavy-tailed On-Off process arrivals and constant-rate service (control). The control problem is to find the optimal value of the service rate which minimizes an infinite horizon discounted cost function. The main result of the paper guarantees the existence of an optimal rate as well as specifies an explicit range of possible values of this optimal rate. As a part of the analysis, we also formulated and solved an approximating control problem driven by fractional Brownian motion. A key ingredient of the proof (and a result of independent interest) is an asymptotic maximal bound on the second moment of the centered cumulative On-Off process, which is also derived. (Received February 08, 2012)

1081-60-182 **Xiangdong Liu, Chris Evans, Shu Wu and Yong Zeng*** (zengy@umkc.edu), 5100 Rockhill Road, UMKC Dept of Math and Stat, Kansas City, MO 64110. *The Multifactor Term Structure of Interest Rates under Regime Shifts and Levy Jumps.* Preliminary report.

This paper develops a tractable dynamic term structure models under jump-diffusion with Levy Jump and regime shifts with time varying transition probabilities. The model allows for regime-dependent jumps while both jump risk and regime-switching risk are priced. Two types solutions, including (log-linear) approximation solution and exact solution for the term structure are obtained for an affine-type model under different conditions. For the approximate solutions, we further obtain the error bound, which is of first order only. For the exact solutions, we further obtain closed form solutions to special cases. (Received February 10, 2012)

1081-60-212 **Fredrik Johansson Viklund, Alan A. Sola*** (A.Sola@statslab.cam.ac.uk) and **Amanda Turner.** *Scaling limits in anisotropic conformal aggregation models.*

We study certain planar random growth processes defined in terms of iterations of conformal maps. The models we consider differ from the usual Hastings-Levitov models of aggregation in that preferred directions in the growth are present.

I will discuss both global rescaling of clusters and small-particle scaling limits, and I will indicate how the limit objects that arise can be described using the Loewner equation. (Received February 12, 2012)

1081-60-237 **Jason Swanson***, University of Central Florida, Dept. of Math., 4000 Central Florida Blvd, P.O. Box 161364, Orlando, FL 32816. *The calculus of differentials for the weak Stratonovich integral.*

The weak Stratonovich integral is defined as the limit, in law, of Stratonovich-type symmetric Riemann sums. We derive an explicit expression for the weak Stratonovich integral of $f(B)$ with respect to $g(B)$, where B is a fractional Brownian motion with Hurst parameter $1/6$, and f and g are smooth functions. We use this expression to derive an Itô-type formula for this integral. As in the case where g is the identity, the Itô-type formula has a correction term which is a classical Itô integral, and which is related to the so-called signed cubic variation of $g(B)$. Finally, we derive a surprising formula for calculating with differentials. We show that if $dM = X dN$, then $Z dM$ can be written as $ZX dN$ minus a stochastic correction term which is again related to the signed cubic variation. (Received February 13, 2012)

1081-60-306 **Hongwei Long*** (hlong@fau.edu), Department of Mathematical Sciences, Florida Atlantic University, 777 Glades Road, Boca Raton, FL 33431, and **Yasutaka Shimizu** and **Wei Sun**. *Least squares estimator for discretely observed stochastic processes driven by additive small Lévy noises.*

We study the problem of parameter estimation for stochastic differential equations driven by additive small Lévy noises, observed at n regularly spaced time points $t_i = i/n$, $i = 1, \dots, n$ on $[0, 1]$. We don't impose any moment conditions on the driving Lévy process. Least squares method is used to obtain an estimator of the drift parameter. Under certain regularity conditions on the drift coefficient function, we obtain the consistency and rate of convergence of the least squares estimator (LSE) when a small dispersion coefficient $\varepsilon \rightarrow 0$ and $n \rightarrow \infty$ simultaneously. The asymptotic distribution of the LSE in our general setting is shown to be the convolution of a normal distribution and a distribution related to the jump part of the Lévy process. The obtained results are different from the classical cases where asymptotic distributions are normal. (Received February 13, 2012)

1081-60-324 **Yaozhong Hu** (hu@math.ku.edu), **Fei Lu*** (feilu@math.ku.edu) and **David Nualart** (nualart@math.ku.edu). *Convergence of Probability Densities of Some Nonlinear Functionals of Gaussian Processes.*

We consider random variables given by nonlinear functionals of Gaussian processes. Malliavin calculus is used to determine if the probability law of such a random variable has a density or not. In this talk, I will present some results on the convergence of the densities of a sequence of normalized multiple stochastic integrals to a normal density. I will also explain how the small ball probability technique can be used to verify the condition of existence of negative moments of Malliavin covariance matrix. (Received February 14, 2012)

1081-60-341 **Jian Song*** (jsong2@math.rutgers.edu), Department of Mathematics, Rutgers University, 110 Frelinghuysen Rd., Piscataway, NJ 08854. *Maximum Principle for General Controlled Systems Driven by Fractional Brownian Motions.*

We obtain a maximum principle for stochastic control problem of general controlled stochastic differential systems driven by fractional Brownian motions (of Hurst parameter $H > 1/2$). This maximum principle specifies a system of equations that the optimal control must satisfy (necessary condition for the optimal control). This system of equations consists of a backward stochastic differential equation driven by both fractional Brownian motion and the corresponding underlying standard Brownian motion. In addition to this backward equations, the maximum principle also involves the Malliavin derivatives. Our approach is to use conditioning and Malliavin calculus. To arrive at our maximum principle we need to develop some new results of stochastic analysis of the controlled systems driven by fractional Brownian motions via fractional calculus. Our approach of conditioning and Malliavin calculus is also applied to classical system driven by standard Brownian while the controller has only partial information. As a straightforward consequence, the classical maximum principle is also deduced in this more natural and simpler way. (Received February 14, 2012)

1081-60-346 **Xiaoming Song***, xmsong@email.unc.edu. *Approximation schemes of the solution of a stochastic differential equation driven by fractional Brownian motion.*

Some approximation schemes of the solution of a multi-dimensional stochastic differential equation driven by fractional Brownian motion are concerned. Unlike the one-dimensional case, there is no representation for the solution. By means of fractional integrals and derivatives, we are able to obtain an optimal rate of convergence. (Received February 14, 2012)

1081-60-380 **Brent M. Werness*** (bwerness@math.uchicago.edu). *Geometric properties of the Schramm–Loewner Evolution.*

Schramm–Loewner Evolutions (SLEs) are a recently defined one-parameter family of random curves which arise naturally as the scaling limit of a number discrete models from statistical physics—specifically models which have been long believed to have a conformally invariant scaling limit. These processes turn out to have a very natural description in terms of the Loewner differential equation from complex analysis, however this description often makes the discussion of geometric quantities associated to SLE sample paths difficult.

In this talk, I will first provide a brief introduction to the SLE process and its basic properties. I will then explain two recent results on the geometry of the sample paths of the SLE process. First, I will discuss recent joint work with Greg Lawler on defining what is called the *multi-point Green's function* of SLE, which provides a way to estimate the probability that an SLE sample path passes very near a pair of points. Then, I will present a second result concerning the winding number of radial SLE, a type of SLE, around its terminal point and show how that leads to a notion known as the *parafermionic observable*. (Received February 14, 2012)

1081-60-385 **Nathan Edward Glatt-Holtz***, 915 Woodbridge Dr., Bloomington, IN 47408. *New Results for the Stochastic PDEs of Fluid Dynamics.*

The addition of white noise driven terms to the fundamental equations of physics and engineering are used to model numerical and empirical uncertainties. In this talk we will discuss some recent results for the Stochastic Navier-Stokes and Euler Equations as well as for the Stochastic Primitive Equations, a basic model in geophysical scale fluid flows. For all of the above systems our results cover the case of a general nonlinear multiplicative stochastic forcing. (Received February 14, 2012)

62 ► Statistics

1081-62-89 **Bhaskar Bhattacharya*** (bhaskar@siu.edu), Department of Mathematics, Carbondale, IL 62901. *Variable selection under dependence.*

The pattern of zero entries in the inverse covariance matrix of a multivariate normal distribution corresponds to conditional independence restrictions between variables. Covariance selection aims at estimating those structural zeroes from data. We show that the Fenchel dual formulation of the covariance selection problem is insightful and allows one to calculate direct estimates under decomposable models. We generalize covariance selection to a form of multivariate dependence, which includes MTP2 and trends in longitudinal studies as special cases. We present a new algorithm for such dependence models and show that it converges correctly using tools from Fenchel duality. The method developed compares favorably with existing ones as shown via simulation. The methodology is applied on a real data set involving decreasing CD4+ cell numbers from an AIDS study. (Received February 01, 2012)

1081-62-97 **Shunpu Zhang*** (szhang3@unl.edu), Department of Statistics, Lincoln, NE 68583, and **Huann-Sheng Chen**. *A more powerful test procedure for multiple hypothesis testing.*

We propose a new multiple test called the minPOP test and three of its modified versions (the left truncated, the right truncated, and the double truncated minPOP tests) for testing multiple hypotheses simultaneously. Under the independence assumption, these tests have exact control of the global type I error rate. We further propose four multiple testing procedures based on these minPOP tests. We show that these multiple testing procedures have strong control of the family-wise error rate. A method for finding the p-values of the proposed multiple testing procedures after adjusting for multiplicity is also developed. Simulation results show that the minPOP tests in general have higher global power than the existing well known multiple tests, especially when the number of hypotheses being compared is relatively large. Among the multiple testing procedures we developed, we find that the ones based on the left truncated and double truncated minPOP tests tend to have higher number of rejections than the existing multiple testing procedures and the other multiple testing procedures based on the minPOP tests. (Received February 02, 2012)

1081-62-117 **Girly Ramirez**, Manhattan, KS 66506, and **Haiyan Wang*** (hwang@ksu.edu), Department of Statistics, 101 Dickens Hall, K, Manhattan, KS 66506. *A Distribution-Free Test to Detect General Dependence and High Dimensional Variable Selection.*

In this talk, I will present a test of independence between the response variable, which can be discrete or continuous, and a continuous covariate. The method involves first augmenting each pair of the data with a fixed number of nearest neighbors as pseudo replicates. Then a test statistic is constructed by taking the difference of two quadratic forms. The statistic is equivalent to the average lagged correlations between the response and

nearest neighbor local estimates of the conditional mean of response given the covariate. The test will be used in a multi-step nonparametric model selection algorithm to select variables in sparse ultra-high dimensional additive models. First, the variables are screened for evidence of marginal dependence. Then the preselected variables go through a series of nonlinear dependence evaluation following a Most Significant Regression algorithm. The algorithm can be used with continuous or discrete response variable, and when the predictors are linearly or nonlinearly related to the response. Simulation comparisons will be presented. (Received February 05, 2012)

1081-62-132 **Chihoon Lee*** (chihoon@stat.colostate.edu), 102 Statistics Building, Department of Statistics, Colorado State University, Fort Collins, CO 80523-1877, and **Jaya Bishwal** and **Myung Hee Lee**. *Sequential maximum likelihood estimation for reflected Ornstein-Uhlenbeck processes.*

The paper studies the properties of a sequential maximum likelihood estimator of the drift parameter in a one dimensional reflected Ornstein-Uhlenbeck process. We observe the process until the observed Fisher information reaches a specified precision level. We derive the explicit formulas for the sequential estimator and its mean squared error. The estimator is shown to be unbiased and uniformly normally distributed. A simulation study is conducted to assess the performance of the estimator compared with the ordinary maximum likelihood estimator. (Received February 07, 2012)

1081-62-144 **Zhengyuan Zhu*** (zhuz@iastate.edu), 1216 Snedecor Hall, Department of Statistics, Iowa State University, Ames, IA 50011-1210. *Optimal Spatial Sampling Design and Wireless Sensor Networks.*

Spatial sampling design problems have been studied by statisticians to solve problems in many application areas such as agriculture, soil science, ecology, and environmental science. Though many of the methodologies in spatial sampling design can be used to help design the sampling plan of wireless sensor networks (WSN), WSN has some characteristics such as the energy and communication constraints which are not present in a traditional sampling network and poses new challenges to statisticians. In this talk we will give an overview on spatial sampling design and discuss its relationship to the sampling design for WSN. An example of maximum-information predictive designs for model-based geostatistics and some preliminary results on the optimal sampling design of a WSN for parameter estimation under energy and communication constraints will be presented. (Received February 08, 2012)

1081-62-151 **Seth Sullivant*** (smsull12@ncsu.edu), Department of Mathematics, North Carolina State University, Box 8205, Raleigh, NC 27695. *Algebraic aspects of graphical models.*

Graphical models are statistical models on collections of random variables where a combinatorial graph is used to encode local interactions between the random variables. These local interactions are then assembled into a complex structure of long range effects between large collections of random variables.

Graphical models can be represented either parametrically (e.g. as a regression model) or implicitly (e.g. via conditional independence constraints). Both representations can be thought of as fundamentally algebraic-geometric in character, since both descriptions involve polynomials. I will describe some recent results on the algebraic study of graphical models. (Received February 08, 2012)

1081-62-202 **Brent Bundick** and **Yong Zeng*** (zengy@umkc.edu), 5100 Rockhill Road, UMKC Dept of Math and Stat, Kansas City, MO 64110. *Bayes Estimation via Filtering Equation for Partially-observed Heston Stochastic Volatility Model with Marked Point Process Observations.* Preliminary report.

Heston's stochastic volatility (SV) model has been well studied and is regarded as a benchmark model in finance literature. Time-stamped transactions price data are marked point process (MPP) observations. This talk first reviews a general partially-observed framework of Markov processes with MPP observations recently proposed for UHF data; the posterior distribution and the filtering equation, which is a stochastic partial differential equation (SPDE) with recursiveness; and the Bayes Estimation via Filtering Equation (BEFE).

In the past few years, Graphics Processing Units (GPUs) evolved from rendering graphics (linear algebra-like computations) for electronic games and video applications to becoming low-cost and green supercomputing units. With harnessing the newly available GPU supercomputing power in mind and targeting the SV model, we develop a new uniformly consistent recursive algorithm via BEFE for propagating and updating the joint posterior distributions. We show that the recursive algorithm is well suited for GPU computing and we present a simulation result to demonstrate that the recursive algorithm works. Real time volatility track and feed is made possible. (Received February 11, 2012)

1081-62-208 **Weixing Song*** (weixing@ksu.edu), Manhattan, KS 66503. *Distribution-Free Test in Tobit Mean Regression Model.*

This talk discusses the problem of fitting a parametric model in Tobit mean regression models. The proposed test is based on the supremum of the Khamaladze type transformation of a partial sum process of calibrated residuals. The asymptotic null distribution of this transformed process is shown to be the same as that of a time-transformed standard Brownian motion. Consistency of this sequence of tests against some fixed alternatives and asymptotic power under some local nonparametric alternatives are also discussed. Simulation studies are conducted to assess the finite sample performance of the proposed test. The power comparison with some existing tests shows some superiority of the proposed test at the chosen alternatives. (Received February 11, 2012)

1081-62-243 **Min Yang*** (yangmi@missouri.edu), 146 Middlebush Hall, Department of Statistics, University of Missouri, Columbia, MO 65211. *On the de la Garza phenomenon: a new approach of studying optimal design for nonlinear models.*

Designing experiments is an integral part of the scientific process, both for discovery and verification.

One crucial step in deriving optimal design is to determine the number of support points needed. Current tools handle this on a case-by-case basis. Each combination of model, optimality criterion and objective requires its own proof. The celebrated de la Garza phenomenon states that under a polynomial regression model, any optimal design can be based on a design with minimum number of support points

In this talk, we will introduce a new approach of studying optimal designs. Using this new approach, it can be easily shown that the de la Garza phenomenon exists for many commonly studied nonlinear models. The proposed approach unifies and extends many well-known results in the optimal design literature. It has four advantages over current tools: (i) it can be applied to many forms of nonlinear models; to continuous or discrete data; to data with homogeneous or nonhomogeneous errors; (ii) it can be applied to any design region; (iii) it can be applied to multiple-stage optimal design and (iv) it can be easily implemented. (Received February 13, 2012)

1081-62-248 **Ibrahim A. Ahmad** (iahmad@okstate.edu), Department of Statistics, Oklahoma State University, Stillwater, OK 74078, and **Lichi Lin*** (lichi.lin@okstate.edu), Department of Statistics, Oklahoma State University, Stillwater, OK 74078. *Generalized Likelihood Inference in the Multivariate Normal for Heterogeneous Data.*

When extending likelihood inference in the case of the normal distribution to heterogeneous samples, one discover that this is easily done in the univariate case but is prohibitive in the multivariate cases.

In the current work, the exact maximum likelihood estimates for the core mean and the covariance matrix are obtained for samples of different means but with core parameter vector and an unknown covariance matrix but a structured one. Then the celebrated Hottelling's T-square statistic is generalized to this case where the exact distribution is derived. The Wald approximate Chi-Square test is then obtained as well.

Next, we derive analogous results in the c-sample situation. Our generalized Hottelling T square statistics developed allows us to proceed to testing hypotheses in the one-way multivariate ANOVA when samples are not homogeneous. A cutting edge application of this work is the introduction to Meta analysis approaches for multivariate heterogeneous data for the first time. (Received February 13, 2012)

1081-62-255 **Yuan Wang, J.S. Marron, Burcu Aydin, Alim Ladha, Elizabeth Bullitt and Haonan Wang*** (wanghn@stat.colostate.edu). *Nonparametric Regression Model with Tree-structured Response.*

Highly developed science and technology from the last two decades motivated the study of complex data objects. In this talk, we consider the topological properties of a population of tree-structured objects. Our interest centers on modeling the relationship between a tree-structured response and other covariates. For tree objects, this poses serious challenges since most regression methods rely on linear operations in Euclidean space. We generalize the notion of nonparametric regression to the case of a tree-structured response variable. In addition, a fast algorithm with theoretical justification is developed. We implement the proposed method to analyze a data set of human brain artery trees. An important lesson is that smoothing in the full tree space can reveal much deeper scientific insights than the simple smoothing of summary statistics. (Received February 13, 2012)

1081-62-299 **Juan Du*** (dujuan@ksu.edu), 108D Dickens Hall, Department of Statistics, Kansas State University, Manhattan, KS 66503, and **Chunsheng Ma** and **Samuel Seth Demel.** *Compactly supported covariance matrix models with application to spatial covariance tapering.*

We derive several classes of covariance matrix functions whose entries are compactly supported. These compactly supported matrix functions are used as building blocks to formulate other covariance matrix functions for

modeling of second-order vector stochastic processes or random fields. In particular, a multivariate version of the celebrated spherical model is derived, as well as a class of second-order multivariate stochastic processes whose direct and cross covariance functions are of Pólya type. On the other hand, some of the proposed compactly supported correlation matrix functions are employed as the tapering matrix function in the multivariate covariance tapering technique, which is helpful to mitigate the numerical burdens in dealing with the large spatial data sets by making covariance matrices sparse. Simulation study is conducted to show the computational efficiency and application in spatial prediction by using proposed multivariate tapering technique. (Received February 13, 2012)

1081-62-302 **Paul L. Speckman*** (speckmanp@missouri.edu), Department of Statistics, University of Missouri, Columbia, MO 65211, and **Dongchu Sun**. *Bayes Factors for One-Way ANOVA*. Preliminary report.

We consider the problem of choosing objective priors for consistent Bayes factors in linear models. We analyze the special case of one-way ANOVA with fixed or random effects, letting the number of factor levels be fixed or increasing with sample size. We show that the popular Zellner-Siow and related priors are not necessarily consistent in the large parameter case. However, a simple modification based on notions of “effective sample size” produces consistent Bayes factors in all cases. (Received February 13, 2012)

1081-62-327 **Luis A. Barboza*** (lbarboza@purdue.edu), 250 N. University Street, West Lafayette, IN 47907. *Joint Parameter Estimation of Ornstein-Uhlenbeck SDEs driven by Fractional Brownian Motion*.

We provide a joint estimate for the drift and Hurst parameters of a stationary Ornstein-Uhlenbeck (OU) process driven by a fractional Brownian motion with $\sigma = 1$. This estimator is based on a system of moment equations involving filters of different orders and the autocovariance function of the stationary OU process. We work with two alternative solutions to this problem, using different representations of the underlying fractional Brownian motion depending on whether or not the process has long memory. Using the asymptotic theory of the Generalized Method of Moments, the consistency and asymptotic normality of this estimator are established. We are still investigating a possible MLE solution to this problem. Finally, a simulation study is done under different scenarios. (Received February 13, 2012)

65 ► Numerical analysis

1081-65-12 **Lin Mu, Junping Wang, Yanqiu Wang and Xiu Ye***, 2801 S. University Ave, Little Rock, AR 72204. *Weak Galerkin finite element methods for partial differential equations*.

Newly developed weak Galerkin finite element methods will be introduced for solving partial differential equations. Like discontinuous Galerkin methods, weak Galerkin finite element methods allow to use discontinuous functions in finite element procedure which makes weak Galerkin methods highly flexible. Unlike DG methods, weak Galerkin finite element methods enforce weak continuity of variables naturally though well defined discrete differential operators. Therefore, weak Galerkin methods are parameter independent and absolutely stable. Error analysis and numerical experiments are presented. (Received November 01, 2011)

1081-65-14 **Jue Yan*** (jyan@iastate.edu), Iowa State University, Ames, IA 50010. *A Local Discontinuous Galerkin method for Hamilton-Jacobi Equations*.

Different to Hu-Shu’s paper in 1999, we propose a local discontinuous Galerkin method to directly solve Hamilton-Jacobi equations. For the linear case, the method is equivalent to the discontinuous Galerkin method for conservation laws. Thus, stability and error analysis are valid. For both convex and nonconvex Hamiltonian, optimal $(k+1)$ -th order of accuracy for smooth solutions are obtained with piecewise k -th polynomial approximations. The schemes are numerically tested on a variety of one and two dimensional problems. The method works well to capture sharp corners (discontinuous derivatives) and converges to the viscosity solution. (Received November 15, 2011)

1081-65-23 **David Seal*** (rossmani@math.wisc.edu), 480 Lincoln Drive, Madison, WI 53715, and **James Rossmannith** (rossmani@math.wisc.edu). *Positivity-Preserving Space-Time DG-FEM for Kinetic Vlasov Models of Plasma*.

The Vlasov system describes the evolution of a collisionless plasma, represented through one or more PDFs that interact via electromagnetic forces. One of the main difficulties in numerically solving this system is the severe time-step restriction that arises from parts of the PDF associated with large velocities. The dominant approach in the plasma physics community for removing these time-step restrictions is the so-called particle-in-cell (PIC)

method, which discretizes the distribution function into a set of macro-particles, while the electromagnetic field is represented on a mesh. In this work we present an alternative to the PIC methodology using high-order space-time discontinuous Galerkin-FEM. A novel aspect of this work is that we formulate the method in such a way that the most expensive part of the numerical update (i.e., the solution of a large system of algebraic equation) is linear. Positivity-preserving limiters are developed that ensure that the numerically computed solution remains physical. The proposed method is applied to several test cases. (Received December 20, 2011)

1081-65-46 **Jens P. Lang*** (lang@mathematik.tu-darmstadt.de), Technische Universität Darmstadt, Department of Mathematics, Dolivostr. 15, 64293 Darmstadt, Germany. *Linearly Implicit Time Integrators for Optimal Control Problems.*

In this talk, we will consider time discretizations of linearly implicit type for ODE-constrained nonlinear optimal control problems. The ODE is first discretized and the arising discrete optimal control problem is then solved by approximating the first order optimality conditions. For Runge-Kutta methods, additional order conditions have to be satisfied to achieve order three for optimal control problems (Hager, 2000). For large scale problems, the complexity of implicit Runge-Kutta schemes can be significantly reduced by applying linearly implicit Runge-Kutta-Rosenbrock methods with inexact Jacobians. We will present order conditions for these methods up to order three. The performance of newly designed methods is discussed for academic as well as real-life problems. (Received January 17, 2012)

1081-65-69 **Xuemin Tu*** (xtu@math.ku.edu), Department of Mathematics, University of Kansas, 1460 Jayhawk Blvd, Lawrence, KS 66045, and **Jing Li** (li@math.kent.edu), Department of Mathematical Sciences, Kent State University, Kent, OH 44242. *A unified FETI-DP approach for incompressible Stokes equations.*

A unified framework of FETI-DP algorithms is proposed for solving the system of linear equations arising from the mixed finite element approximation of incompressible Stokes equations. Under this framework, several previously developed FETI-DP algorithms can be represented and their condition number estimates can be simplified. A distinctive feature of this framework is that both continuous and discontinuous pressures can be used in the finite element space, while previous FETI-DP algorithms are valid only for discontinuous pressures. Both lumped and Dirichlet type preconditioners are analyzed and scalable convergence rates are proved. Numerical experiments of solving a two-dimensional incompressible Stokes problem also demonstrate the performances of the discussed FETI-DP algorithms represented by the same framework. (Received January 27, 2012)

1081-65-104 **Hongqiang Zhu** and **Jianxian Qiu*** (jxqiu@xmu.edu.cn), School of Mathematical Sciences, Xiamen University, Xiamen, Fujian, Peoples Rep of China. *An h-adaptive RKDG method with different troubled-cell indicators for hyperbolic conservation laws.*

In this presentation, we systematically investigate h -version adaptive Runge-Kutta discontinuous Galerkin (RKDG) methods for hyperbolic conservation laws with different indicators which were based on the troubled cell indicators studied by Qiu and Shu [SIAM J. Sci. Comput., 27 (2005), 995-1013]. The emphasis is on comparison of the performance of adaptive RKDG method using different indicators, with an objective of obtaining efficient and reliable indicators to obtain better performance for adaptive computation to save computational cost. The idea is to first identify “troubled cells” by different troubled-cell indicators, namely those cells where limiting might be needed and discontinuities might appear, then adopt an adaptive approach in these cells. A detailed numerical study in one and two dimensional cases is performed, addressing the issues of efficiency (less CPU cost and more accurate), non-oscillatory property, and resolution of discontinuities. (Received February 03, 2012)

1081-65-107 **Laurent O Jay*** (laurent-jay@uiowa.edu), Department of Mathematics, 14 MacLean Hall, The University of Iowa, Iowa City, IA 52242. *Low order methods for constrained systems in mechanics.*

We present extensions of the generalized- α method of Chung and Hulbert and of the symplectic Euler method for systems in mechanics with constraints. Convergence results will be given. (Received February 03, 2012)

1081-65-137 **Qifang Su*** (suqf_tzc@163.com), Linhai, Zhejiang 317000, Peoples Rep of China. *Analysis of Backward Error and Condition for Polynomial Eigenproblems.* Preliminary report.

We develop backward errors and condition numbers for the polynomial eigenvalue problem, and derive some computable backward errors and condition numbers in both normwise and componentwise measures. The standard way of dealing with this problem is to reformulate it as a generalized eigenvalue problem (GEP). For the special

case of the quadratic eigenvalue problem (QEP), we analyze the stability and quality of QEP by applying the QZ algorithm to a corresponding GEP. (Received February 07, 2012)

1081-65-145 **Xiaofan Li*** (lix@iit.edu), E1-208, 10 W 32nd St, Chicago, IL 60616, and **Allen Flavell, Bob Eisenberg** and **Chun Liu**. *A conservative finite difference method for PNP equations*. Preliminary report.

PNP or drift diffusion equations models the motion of the ionic flow in media and solvents and transport in semiconductor devices. We present a finite difference method that preserves the total amount of each ionic species in time perfectly. Using numerical examples, we also demonstrate the conservation property is important in finding the equilibrium solutions to the corresponding steady-state equations (Poisson-Boltzmann equations). (Received February 08, 2012)

1081-65-147 **JaEun Ku*** (jku@math.okstate.edu), 401 Mathematical Sciences, Stillwater, OK 74078. *Goal-oriented local a posteriori error estimators for $H(\text{div})$ least-squares finite element methods*.

In this talk, we present a goal-oriented, local *a posteriori* error estimator for $H(\text{div})$ least-squares (LS) finite element methods. Our main interest is to develop an *a posteriori* error estimator for the flux approximation in a preassigned region of interest $D \subset \Omega$. The estimator is obtained from the LS functional by scaling residuals with proper weight coefficients. The weight coefficients are given in terms of local mesh size h_T and a function ω_D depending on the distance to D . This new error estimator measures the pollution effect from the outside region of D and provides a basis for local refinement in order to efficiently approximate the solution in D . Numerical experiments show superior performances of our goal-oriented *a posteriori* estimators over the standard LS functional and global error estimators. This is a joint work with Prof. Cai at Purdue University. (Received February 08, 2012)

1081-65-173 **Shuwang Li*** (sli@math.iit.edu), Engineering 1 Building, Room 208, 10 West 32nd Street, Chicago, IL 60616, and **Kai Liu**. *Dynamics of a vesicle in viscous fluids*.

In this talk, I will present the modeling and computation of a multicomponent vesicle and study its dynamics in viscous flow. Recent experimental results on giant unilamellar vesicles (GUVs) show that mixed multiple lipid components on the surface of a membrane may decompose into coexisting phases with distinct compositions, with concomitant changes in the surface morphology. The driving forces for the evolution involves line tension along the phase boundaries, inhomogeneous surface/bending energy, and fluid forces. Here we are interested in exploring the emergent morphologies of a vesicle in shear flow and in extensional flow. Our numerical results suggest that the nonhomogeneous surface tension/bending, together with the flow, introduces nontrivial dynamics including locomotion, budding, tumbling and wrinkling. (Received February 13, 2012)

1081-65-200 **Jiahong Wu*** (jiahong@math.okstate.edu), Department of Mathematics, Oklahoma State University, 401 Mathematical Sciences, Stillwater, OK 74078. *Recent numerical results on the surface quasi-geostrophic equation*.

The surface quasi-geostrophic (SQG) equation models actual geophysical flows in the atmosphere and is useful in understanding certain weather phenomena such as the frontogenesis. In addition, it is an active scalar equation with very special structure and has been used as a testbed for some turbulence theories. Mathematically the SQG equation shares many parallel properties with the 3D incompressible Navier-Stokes and the Euler equations and serves as a lower-dimensional model of these 3D equations in the study of the global regularity issue. The global regularity problem on the SQG equation itself turns to be very difficult. Extensive numerical simulations have been performed to gain insight into the potentially singular behavior of its solutions. This talk presents results of some recent computations aiming at the global regularity problem and at understanding how the regularity is affected by certain key parameters. Numerically the SQG equation is solved on a periodic box with a pseudo-spectral method (Fourier modes up to 4096^2) and time stepping through a fourth-order Runge-Kutta method. This is a joint work with Constantin, Lai, Sharma and Tseng. (Received February 11, 2012)

1081-65-210 **Ming-Jun Lai** and **Jingyue Wang*** (jwang@math.ku.edu), Department of Mathematics, University of Kansas, Lawrence, KS 66045, and **Qianying Hong**. *Convergence Analysis of a Finite Difference Scheme for the Gradient Flow associated with the ROF Model*. Preliminary report.

We present a convergence analysis of a finite difference scheme for the time dependent partial differential equation called gradient flow associated with the Rudin-Osher-Fatemi model. We devise an iterative algorithm to compute the solution of the finite difference scheme and prove the convergence of the iterative algorithm. (Received February 12, 2012)

1081-65-219 **Yanqiu Wang*** (yqwang@math.okstate.edu), Department of Mathematics, Oklahoma State University, Stillwater, OK 74078. *Weak Galerkin method for biharmonic equations.*

This talk focuses on a weak Galerkin method for the biharmonic equation. It is a joint work with M. Lin, J. Wang, and X. Ye. The idea of the weak Galerkin method is to use a weakly defined gradient operator in the finite element discretization, which allows the use of totally discontinuous function spaces. Different from the discontinuous Galerkin method, the weak Galerkin method does not explicitly employ inter-element averages or jumps. The biharmonic problem is first rewritten into its Ciarlet-Raviart mixed formulation. Then, both the primal and the dual variables are discretized using equal-order weak Galerkin elements. Error estimations will be presented. (Received February 12, 2012)

1081-65-257 **Xianping Li*** (XianpingL@uca.edu) and **Weizhang Huang** (huang@math.ku.edu).
Discrete Maximum Principle and Mesh Adaptation for Anisotropic Diffusion Problems.

Anisotropic diffusion problems arise in many fields of science and engineering including plasma physics, petroleum engineering, and image processing. The continuous solution satisfies the maximum principle. However, standard numerical methods can produce spurious oscillations when they are used to solve those problems. A common approach to avoid this difficulty is to design a proper numerical scheme and/or a proper mesh so that the numerical solution validates the discrete maximum principle (DMP).

In this talk, a so-called anisotropic non-obtuse angle condition is presented for steady state anisotropic diffusion problems that guarantees the linear finite element solution to satisfy DMP. The condition is the generalization of the well-known non-obtuse angle condition in the sense that the dihedral angles are non-obtuse measured in a metric depending on the diffusion matrix of the underlying problem. A metric tensor is developed for use in anisotropic mesh adaptation to account for DMP satisfaction. The combination of DMP satisfaction and mesh adaptivity is considered for the first time. Numerical examples are given to demonstrate the features of the anisotropic meshes generated with the metric tensors. Further generalization of the non-obtuse angle condition is discussed. (Received February 13, 2012)

1081-65-274 **Lennard Kamenski*** (lkamenski@math.ku.edu), **Weizhang Huang** and **Hongguo Xu**.
Anisotropic meshes and conditioning of finite element equations.

It has been proven by Bank and Scott that the condition number of finite element equations does not degrade significantly on adaptive meshes if the mesh is quasi-uniform and the system is appropriately scaled. In this talk, we present a generalization of this result to general (anisotropic) meshes. As in isotropic case, an appropriately chosen, mesh-dependent diagonal scaling can significantly improve the conditioning of the resulting linear system. A particular consequence is that the bound on the condition number of the scaled system is mostly the same as for the uniform case even if the mesh contains anisotropic elements, provided the number of anisotropic elements is relatively small. (Received February 13, 2012)

1081-65-288 **Thomas K DeLillo*** (delillo@math.wichita.edu), Dept of Mathematics, Statistics, and Physics, Wichita State University, Wichita, KS 67260-0033. *Numerical computation of the Schwarz-Christoffel transformation for multiply connected domains - an overview.*
Preliminary report.

We will give an overview of the extension of the Schwarz-Christoffel transformation to multiply connected domains and report on the numerical implementation of the formulas. We will discuss recent significant improvements to the efficiency of the computations based on the use of Laurent series approximations to certain boundary value problems on domains bounded by circles. This is joint work with A. R. Elcrat, E. H. Kropf, and J. A. Pfaltzgraft. (Received February 13, 2012)

1081-65-292 **Hongguo Xu*** (xu@math.ku.edu), 405 Snow Hall, Department of Mathematics, University of Kansas, Lawrence, KS 66045. *Convergence of QR algorithm with Rayleigh-quotient shift for normal matrices.*

We show the convergence behavior of the QR algorithm with Rayleigh-quotient shift when it is applied to a normal matrix. We provide detailed information to reveal how the convergence behavior and convergence rate are determined completely by the location of the normal matrix eigenvalues and the initial vector for the first Hessenberg reduction. (Received February 13, 2012)

1081-65-325 **Michael James Pollack*** (mpollack@iastate.edu). *Alternating evolution schemes for Hamilton-Jacobi equations.*

We propose a high resolution Alternating Evolution (AE) scheme to solve Hamilton-Jacobi equations. The construction of the AE scheme is based on an alternating evolution system of the Hamilton-Jacobi equation. A semi-discrete scheme derives directly from a sampling of this system on alternating grids. Higher order accuracy

is achieved by a combination of high-order non-oscillatory polynomial reconstruction from the obtained grid values and a time discretization with matching accuracy. Local AE schemes are made possible by choosing the scale parameter to reflect the local distribution of the waves. The AE schemes have the advantage of easy formulation and implementation, and efficient computation of the solution. (Received February 13, 2012)

1081-65-326 **Mahboub Baccouch***, DSC 233, 6001 dodge st., omaha, NE 68182. *A local discontinuous Galerkin method for the second-order wave equation.*

We present new superconvergence results for the LDG method applied to the second-order scalar wave equation in one space dimension. We show that the leading terms of the spatial discretization errors for the p -degree LDG solution and its spatial derivative are proportional to the $(p + 1)$ -degree right Radau and $(p + 1)$ -degree left Radau polynomials, respectively. More precisely, we prove that the global discretization error for the LDG solution is $O(h^{p+3/2})$ superconvergent at the roots of the right Radau polynomial of degree $p + 1$ and the solution's derivative converges as $O(h^{p+3/2})$ at the roots of the $(p + 1)$ -degree left Radau polynomial while a local error analysis and computational results and show higher $O(h^{p+2})$ convergence rates at the roots of Radau polynomials of degree $p + 1$ on each element for both the solution and its derivative. These results are used to construct asymptotically correct a posteriori error estimates. We further show that the LDG discretization error estimates converge to the true spatial errors under mesh refinement. Finally, we prove that the global effectivity indices, for both the solution and its derivative, in the L^2 -norm converge to unity at $O(h^{1/2})$ rates. Several numerical simulations are performed to validate the theory. (Received February 13, 2012)

1081-65-348 **Hailiang Liu*** (hliu@iastate.edu), Ames, IA 50011, and **OLOF RUNBORG** and **NICOLAY M. TANUSHEV**. *ERROR ESTIMATES FOR GAUSSIAN BEAM SUPERPOSITIONS.*

Gaussian beams are asymptotically valid high frequency solutions to hyperbolic partial differential equations, concentrated on a single curve through the physical domain. Superpositions of Gaussian beams provide a powerful tool to generate more general high frequency solutions that are not necessarily concentrated on a single curve. This work is concerned with the accuracy of Gaussian beam superpositions in terms of the wavelength. We present a systematic construction of Gaussian beam superpositions for all strictly hyperbolic and Schrodinger equations subject to highly oscillatory initial data of the WKB form. Through a careful estimate of an oscillatory integraloperator, we prove that the k -th order Gaussian beam superposition converges to the original wave field at an optimal rate in the appropriate norm dictated by the well-posedness estimate. In particular, we prove that the Gaussian beam superposition converges at this rate for the acoustic wave equation in the standard, wavelength-scaled, energy norm and for the Schrodinger equation in the L^2 norm. The obtained results are valid for any number of spatial dimensions and are unaffected by the presence of caustics. (Received February 14, 2012)

1081-65-364 **Mohamed Badawy*** (mbadawy@math.ku.edu), 405 Snow Hall, 1460 Jayhawk Blvd., University of Kansas, Lawrence, KS 66045, and **Erik S. Van Vleck** (evanvleck@math.ku.edu). *A Perturbation Theory for Lyapunov Exponents for Sequences of Operators on a Hilbert Space and Techniques for Approximation of Global Lyapunov Exponents.*

In this talk we will go over results from two recent research projects. In the first one, we develop a perturbation analysis for stability spectra (Lyapunov exponents and Sacker-Sell spectrum) for products of operators on a Hilbert space based upon the discrete QR technique. Error bounds are obtained in both the integrally separated and non-integrally separated cases and for both real and complex valued operators. We illustrate our results using a linear parabolic partial differential equation in which the strength of the integral separation determines the sensitivity of the stability spectra.

In the second, we develop a continuation technique to approximate the (nonlinear) global Lyapunov exponents. Utilising the defining optimization criteria for the global exponents, we use the method of Lagrange multipliers to turn the optimization problem into a system of equations that can then be solved using a Jacobian free Newton's method. (Received February 14, 2012)

1081-65-399 **Hailiang Liu** and **Hui Yu*** (legendyu@iastate.edu). *ENTROPY/ENERGY STABLE SCHEMES FOR EVOLUTIONARY DISPERSAL EQUATIONS.* Preliminary report.

We propose entropy/energy stable finite difference schemes for the scalar reaction-diffusion-advection equation arising in population dynamics of biological dispersal. The peculiar feature of these active dispersal models is that the transient solution converges to the stable steady state when time goes to infinity. For the numerical method to capture the long-time pattern of persistence or extinction, we introduce a concept of entropy when

the resource potential is logarithmic, and explore the usual energy for other resource potentials. The present schemes are shown to satisfy three important properties of the continuous model for the population density: i) positivity preserving; (ii) equilibrium preserving; and iii) entropy or energy satisfying. These ensure that our schemes provide a satisfying long- time behavior, thus revealing the desired dispersal pattern. Moreover, we present several numerical results which confirm the second-order accuracy for various resource potentials and underline the efficiency to preserve the large-time asymptotic. (Received February 14, 2012)

70 ► *Mechanics of particles and systems*

1081-70-159 **Angel Ivanov Zhivkov*** (zhivkov@fmi.uni-sofia.bg), Faculty of Mathematics and Informatics, 5 James Bouchier Blvd., Sofia, 1164. *Short-time stability of the solar system.*

We consider the Sun, Mercury, Venus, Earth+Moon, Mars, Jupiter, Saturn, Uranus and Neptune as point masses, moving according to Newton's law of universal gravitation. With the help of two canonical transformations, all mean anomalies have been eliminated up to the third order of masses. Our calculations are based on the observation that each mean motion is very nearly to a square root of some not very large integer. For example, the ratio between Jupiter's and Saturnian years - the number of Laplace 2.483..., is nearly $\sqrt{37} : \sqrt{6}$. Such a fact cancels any small divisor. Finally we prove a theorem that the present configuration will be stable at least during the next 10 million years in sense that any semi-major axis would not change significantly and every eccentricity and inclination will remain bounded. (Received February 13, 2012)

76 ► *Fluid mechanics*

1081-76-16 **RAMU ADDEPALLI*** (addepallir@gmail.com, aramu@bits-hyderabad.ac.in), Department Of Mathematics, BITS-Pilani, Hyderabad Campus Shameerpet, 500078, Andhrapradesh, INDIA, 500078, India, and **Narasimhulu Dunna** (narsimha.maths@gmail.com), Department Of Mathematics, BITS-Pilani, Hyderabad Campus Shameerpet, 500078, Andhrapradesh, INDIA, India. *Similarity solutions for shock waves in non-ideal magnetogasdynamics.*

Similarity solutions of second kind to the problem shock waves generated due to implosion in non-ideal medium satisfying the Mie-Grüneisen type are investigated. The similarity exponent is evaluated numerically. The flow profiles have been presented for the non-ideal magnetogasdynamics study. A comparative study has been presented for the numerical solutions obtained by using CCW approximation method. The effect of magnetic field on the shock decay coefficient and flow variables such as density, pressure, and velocity is presented. (Received November 18, 2011)

1081-76-125 **C. Lu*** (luchangna@nuist.edu.cn), College of Math and statistics, 219 Ningliu Road, Nanjing, Jiangsu 210044, Peoples Rep of China. *Simulations of Discontinuous Shallow Water flows by Weighted Essential Non-oscillatory Schemes.*

Dam break flows, tidal bore, which are discontinuous shallow water flows, are great disasters to nature. In this talk, the third-order weighted essential non-oscillatory (WENO) finite volume schemes are used to simulate the two-dimensional shallow water equations with the source terms on unstructured triangle meshes. The balance of the flux and the source terms makes the shallow water equations fit to non-flat bottom problems. According to the tests of some typical examples and the simulation of a tidal bore on an estuary with trumpet shape and Qiantang river in China; the results show that the high resolution finite volume schemes can be used to simulate the current flow accurately and catch the stronger discontinuous in water wave, such as dam break and tidal bore effectively. (Received February 06, 2012)

1081-76-266 **Ciprian Foias and Michael Jolly*** (msjolly@indiana.edu), Department of Mathematics, Rawles Hall, 831 E. 3rd Street, Bloomington, IN 47405, and **Ming Yang.** *On single mode forcing of the 2D Navier-Stokes equations.* Preliminary report.

We examine how the global attractor \mathcal{A} of the 2-D periodic Navier- Stokes equations projects in the energy-entropy plane (\mathbf{e}, \mathbf{E}) , when the force is an eigenvector of the Stokes operator A . In particular, we give a lower bound for the projection $\mathbf{Pr} \mathcal{A}$, and prove the existence of some semi-integral curves, which form the upper boundary. We also obtain an estimation of the possible singular solutions in $\mathbf{Pr} \mathcal{A}$. (Received February 13, 2012)

1081-76-367 **Tianshi Lu*** (lu@math.wichita.edu) and **Patrick Rinker**. *Modeling of Multiphase Magnetohydrodynamics in Tokamaks*.

A numerical algorithm for the simulation of MHD in plasma is presented. The Euler equations with electromagnetic terms are solved using Godunov-type Riemann solvers and techniques developed for free surface flows. The algorithm has been applied to the simulation of tokamak refueling. A tokamak, a torus-shaped nuclear fusion reactor, is refueled by frozen hydrogenic pellets. A pellet ablates as it penetrates the plasma. It is critical to guarantee the delivery of the ablated materials into the burning plasma core. We studied the interaction of the pellet ablation flow with the magnetic field. A surface ablation model, a kinetic model for the plasma electron heat flux, and an equation of state accounting for atomic processes in the ablation cloud have been developed. Our study indicated that the magnetic field channeled the ablation flow into an extended plasma shield, which reduced the ablation rate and prolonged the lifetime of the pellet. We have also developed a cloud charging and rotation model for the pellet ablation, which accounted for an increased ablation rate. Recently, we investigated the effect of various physical parameters on the pellet ablation rate, and did benchmark simulations against experimental data from DIII-D tokamak pellet launches. (Received February 14, 2012)

81 ► *Quantum theory*

1081-81-29 **Junwu Tu*** (junwut@uoregon.edu), 320 Fenton Hall University of Oregon, Eugene, OR 97403. *Homological mirror symmetry is Fourier-Mukai transform*.

We interpret symplectic geometry as certain sheaf theory by constructing a sheaf of curved A_∞ algebras which in some sense plays the role of a “structure sheaf” for symplectic manifolds. An interesting feature of this “structure sheaf” is that the symplectic form itself is part of its curvature term. Using this interpretation homological mirror symmetry can be understood by well-known duality theories in mathematics: Koszul duality or Fourier-Mukai transform. In this paper we perform the above constructions over a small open subset inside the smooth locus of a Lagrangian torus fibration. In a subsequent work we shall use the language of derived geometry to obtain a global theory over the whole smooth locus. However we do not know how to extend this construction to the singular locus. As an application of the local theory we prove a version of homological mirror symmetry between a toric symplectic manifold and its Landau-Ginzburg mirror. (Received February 02, 2012)

82 ► *Statistical mechanics, structure of matter*

1081-82-273 **Iliia Binder*** (ilia@math.toronto.edu), Department of Mathematics, University of Toronto, 40 St George St, Toronto, ON M5S 2E4, Canada, and **Stanislav Smirnov**. *Conformal welding and Schramm Löwner Evolution*.

A few non-equivalent ways of obtaining Schramm Loewner Evolution (SLE) from conformal welding were proposed. We will discuss the two-sided multifractal spectrum as a tool for checking the plausibility of the relation of the resulting welded curves and SLE. (Received February 13, 2012)

92 ► *Biology and other natural sciences*

1081-92-27 **Bob Eisenberg*** (beisenbe@rush.edu), Molecular Biophysics 1291 Jelke, Rush University, 1653 West Congress Parkway, Chicago, PA 60612. *Mathematics of Ion Channels: Life's Transistors*.

Ion channels are proteins with a hole down their middle that control flow across otherwise impermeable membranes. Electric current propagates signals in the nervous system and coordinates contraction. Ion channels are a large class of proteins involved in many diseases, and the response to many drugs. Simulations so far have been uncalibrated and unhelpful in dealing with the functional properties of ion channels. Ion channels are suitable for mathematical analysis because the underlying physics is understood and simple. Once open, ion channels have one structure (on the biological time scale > 10 microseconds). Ions move through that structure driven by diffusion and electric forces. The diameter of ions is smaller than the hole in the protein, but it is never negligible. Indeed, the number density of ions in the channel is very high, because the large permanent charge of the channel protein must be balanced by a (nearly) equal amount of mobile charge. Theories of ion channels that neglect the steric repulsion of ions are not useful. They are also not helpful for bulk (NON-biological systems) in almost all cases. The mathematical challenge is to deal with the correlations produced by finite size. Energetic variational methods as developed by Chun Liu are promising. (Received December 23, 2011)

- 1081-92-63 **Lauren Beesley*** (lbeesley@ku.edu), **Xue-Wen Chen** and **Jun Huan**. *Using Normalization Techniques and Matched Analysis to Determine Differential Gene Expression of Oral Squamous Cell Carcinoma*. Preliminary report.

During this talk, we will present some approaches to identify differentially expressed genes and determine statistical significance in microarray experiments. In order to determine differentially expressed genes in patients with oral squamous cell carcinoma, we investigate datasets from matched tumor and normal samples collected from these patients. In each situation, we use normalization techniques and matched analysis to attempt to isolate the genes with statistically significant differences in expression levels between the two conditions. Future applications of these techniques could result in more efficient diagnosis of oral squamous cell carcinoma. (Received January 24, 2012)

- 1081-92-80 **Syafrina Abdul Halim*** (syafrihalim@gmail.com), No. 6, Jalan 3/37, Seksyen 3, 43650 Bandar Baru Bangi, Selangor, Malaysia. *Projections of extreme rainfall events using statistical downscaling in Malaysia*.

Extreme rainfall events are likely to increase in the future under climate change. Several major sectors of the world such as water resources faced the severe impacts caused by these phenomena. Due to this reason, meteorologists and hydrologists are responsible in building up the adaptation strategies to correctly assess risks associated in the future hydrological cycle. To achieve that, information of future extreme rainfall events in fine temporal scale is needed. Therefore, downscaling is used for filling the gaps between both large scale and small scale resolution. To date, there is now a large published literature on the projections of extreme rainfall events using statistical downscaling methods for different climatic variables, in different regions and seasons. However, little attention is given to the temporal scale's downscaling resolution. This paper assesses the current statistical downscaling literature and compares the strengths and weaknesses in the downscaling field specifically for projections of extreme rainfall events in fine temporal scale. (Received January 31, 2012)

- 1081-92-133 **Duan Chen*** (chen.906@mbi.osu.edu), JE 374 Jennings Hall, 1735 Neil Avenue, Columbus, OH 43210, and **Guowei Wei**. *Multiscale and multiphysics modeling and simulation of proton transport through membrane proteins*.

Proton transport is one of the most important and interesting phenomena in living cells; it plays many crucial roles in biological processes such as cellular respiration, ATP synthase, and cancer cell development. Due to special properties of protons and membrane channels, traditional convection-diffusion models are not suitable to study proton flux; quantum dynamics is instead adopted. However, extremely expensive computational costs are required for a full quantum model. The present work proposes a multiscale/multiphysics quantum dynamic in continuum model for proton transport through membrane proteins, in order to balance physical accuracy and simulation efficiency. The current model is in form of total energy framework, from which governing equations are derived. Advanced mathematical tools are developed to handle the challenges in simulations and validity of the proposed model is verified through comparison of the simulations and experimental data. (Received February 07, 2012)

- 1081-92-165 **Bo Deng*** (bdeng@math.unl.edu), Department of Mathematics, University of Nebraska - Lincoln, Lincoln, NE 68506. *A Circuit Model of Neuron*.

The Hodgkin-Huxley model for excitable membrane is phenomenological of which each ion channel is a non-mechanistic aggregate of passive currents due to electromagnetism and ion diffusion and active currents due to ion pumps. Here we separate the aggregate into its three components in terms of their circuit characteristics and demonstrate that the resulting model is capable of generating action potentials, spike bursts, and other novel dynamics such as the Shilnikov chaos. More interestingly, we will demonstrate that unlike HH type models all the action potential and spike-burst dynamics are metastable transient states capable of changing from one state to another without having to break free from any structurally stable state, a property of plasticity. (Received February 09, 2012)

- 1081-92-263 **Yuan-Nan Young*** (yyoung@oak.njit.edu), 519 Cullimore Hall, University Heights, New Jersey Institute of Technology, Newark, NJ 07102, **Christopher Jacobs** (crj2111@columbia.edu), 351 Engineering Terrace, 1210 Amsterdam Ave, Mail Code: 8904, New York, NY 10027, and **Matt Downs**. *Mechano-sensing Primary Cilia*.

In this talk I will first present a brief overview of mechanosensory mechanism relevant to the primary cilium. The primary cilium is a microtubule-based structure that is present in most non-motile mammalian cells. The motile cilia beat and generate mixing fluid flow while the primary cilia are non-motile and do not generate any

motion. In response to the extracellular fluid flow, the primary cilium bends and the mechanotransduction is initiated.

In the second half of the talk I will present modeling work on both the equilibrium shape of a primary cilium under flow and its dynamics. The cilium is modeled as an elastic beam that undergoes large-angle deflection under flow. By combining modeling and experiments, we show that the support from the basal body can be modeled as a nonlinear rotational spring. We obtain good agreement with experiments when we simulate the dynamics of cilium bending and relaxing using parameters that correspond to experimental setup. Details of the rotational spring is further elucidated by the mechanical coupling between an elastic beam and an elastic cylindrical shell. These results shed light on the physics underlying the mechanosensitive ion channel transport. (Received February 13, 2012)

93 ► *Systems theory; control*

1081-93-28 **Aleksandra Gruszka**, Louisiana State University, Department of Mathematics, Baton Rouge, LA 70803-4918, **Michael Malisoff*** (malisoff@lsu.edu), Louisiana State University, Department of Mathematics, Baton Rouge, LA 70803-4918, and **Frederic Mazenc**, Projet INRIA DISCO, CNRS-Supelec, 3 rue Joliot Curie, 91192 Gif-sur-Yvette, France. *Tracking Controllers and Robustness Analysis for UAVs*.

We study a kinematic model that is suitable for control design for high level formation flight of unmanned aerial vehicles. We design controllers that give robust global tracking for a wide class of reference trajectories, in the sense of input-to-state stability with respect to additive uncertainty on the controllers, while satisfying amplitude and rate constraints. We illustrate our work in simulations. (Received December 24, 2011)

97 ► *Mathematics education*

1081-97-55 **Patrick W Thompson** and **Neil Hatfield*** (Neil.Hatfield@asu.edu), School of Mathematical & Statistical Sciences, P. O. Box 871804, Tempe, AZ 85287-1804, and **Cameron Byerley**. *Technology and the Teaching of Calculus*. Preliminary report.

Most textbooks develop the ideas of calculus by first defining limits and the derivative as a limit. Integration is developed as "area under a curve". We take a different approach, motivated by this characterization of calculus: Calculus exists to solve two basic problems—(1) You know how fast something is changing and you want to know how much of it you have; (2) You know how much of something you have and you want to know how fast it is changing. This approach starts with the idea of an accumulation function built from a rate of change function, then segues into deriving rate of change functions from accumulation functions, and ties the two together by emphasizing throughout that you cannot think about one without thinking about the other—an approach that cannot work without the aid of technology. Our presentation will demonstrate the centrality of technology to making this approach to building students' understanding of the calculus. (Received January 20, 2012)

1081-97-333 **Philip B Yasskin*** (yasskin@math.tamu.edu), Department of Mathematics, Texas A&M University, 3368 TAMU, College Station, TX 77843-3368, **Douglas B Meade** (meade@math.sc.edu), Department of Mathematics, University of South Carolina, Columbia, SC 29208, and **Matthew J Barry** (mbarry@tamu.edu), 2500 Morris Ln, Bryan, TX 77802-5311. *Facilitating Student Mathematical Input on Mobile Devices*. Preliminary report.

The Maplets for Calculus is an award-winning collection of computer applets that help students learn precalculus and calculus. The authors are in the process of adapting the applets for use on mobile devices such as phones and slates. Most of the components are readily available. However, there is no convenient way for students to enter their math formulas, either for computation or as answers to non-multiple choice (free response) questions. The existing graphical input programs are written in java and these will not work on mobile devices. We could ask the students to type in a linear input box using the syntax of MathML, LaTeX or some standard computer algebra system, but students find the syntax confusing. It is important to keep the input as natural as possible. We are developing a linear input system using syntax which is as close to natural math as possible but still preserving accurate content information. A graphical display of the input appears instantaneously below the linear input. This system will be flexible enough to allow other modes of input, specifically MathML, LaTeX, various computer algebra systems or pallet-based input. The input interface will be demonstrated and its syntax will be discussed. We welcome comments on improving the syntax. (Received February 14, 2012)

1081-97-353 **Andrew G Bennett*** (bennett@ksu.edu) and **Rachel Manspeaker** (manspeaker@coker.edu). *Data Mining for Differentiated Instruction*.

In a large lecture class, the greatest obstacle to providing personalized, effective education is the anonymity of the students. Data mining provides a method for describing students by making sense of the large amounts of information they generate. Instructors may then take advantage of this analysis to adjust instruction to meet their students' needs. Using exam problem grades, attendance points, and homework scores from the first four weeks of a Studio College Algebra class, the researchers were able to identify five distinct clusters of students. Interviews of prototypical students from each group revealed their motivations, level of conceptual understanding, and attitudes about mathematics. Each student group reacts differently to various elements of the course and assistance strategies. By identifying students who are likely to struggle within the first month of classes, and the recovery strategy that would be most effective, instructors can intercede in time to improve performance. (Received February 14, 2012)

1081-97-363 **Carlos W Castillo-Garsow*** (cwcg@k-state.edu) and **Andrew Bennett** (bennett@ksu.edu). *The Textbook of the Future*. Preliminary report.

What would a textbook look like in an online world? How do changing interfaces and connectivity influence the ways that students interact with mathematical resources? Are there ways that we can combine recent technological innovations in mathematics education to improve out-of-class resources for our students? This talk will combine ideas from several session speakers with the progress of current e-text development being done at Kansas State to speculate on what an interactive, connected, and adaptable e-text of the future might look like, and how such a text meets the changing needs of a diverse student population. (Received February 14, 2012)

1081-97-382 **Douglas B Meade*** (meade@math.sc.edu), Department of Mathematics, University of South Carolina, Columbia, SC 29208, and **Philip B Yasskin** (yasskin@math.tamu.edu), Department of Mathematics, Texas A&M University, 3368 TAMU, College Station, 77843-3368. *On the Role of Assessment in the Design of Online Resources for Learning Mathematics*.

As more online materials become available for mathematics it is important to understand how these resources impact student learning, and how these impacts are affected by factors such as the learning environment and the type of hardware.

The authors have assembled a team of evaluators and mathematics educators to assess the NSF-funded Maplets for Calculus (M4C) project. The M4C is a collection of computer applets designed to help students learn more than 100 topics in precalculus and calculus.

In addition to summative evaluations based on attitudinal surveys completed by students and faculty in pre- and post-course surveys, the assessment team is developing protocols for more formative studies. Two questions at the heart of this work are:

- To what degree do the maplets, individually or collectively, impact student understanding of associated math concepts?
- Is there a relationship between cognitive measures (e.g. achievement and conceptual understanding) and the learning environment (e.g. course content system, handheld device)?

This talk includes the discussion of the assessment methodologies and initial results currently being used for the M4C project as well as those that are being developed. (Received February 14, 2012)

1081-97-406 **Lawrence Moore*** (lang@math.duke.edu). *MathDL: The MAA's Resource for Interactive Articles, Teaching Resources, and News*.

This talk will discuss the many resources available through the Mathematical Sciences Digital Library (MathDL). These include Math in the News, On This Day (in mathematics), the online journal Loci with interactive articles and featuring Loci: Convergence with resources to help instructors use the history of mathematics in their teaching. MathDL also provides extensive reviews of mathematical books at MAA Reviews, while MAA Writing Awards provides bios of authors and PDF copies of articles that have won one of the seven awards for journal writing. New features in MathDL include Course Communities, resources determined to be appropriate for courses from developmental mathematics to differential equations – and materials for a probability course are on the way. Classroom Capsules and Notes features short articles ready for use in the classroom. We have just gathered the capsules for one-variable calculus together, classifying them with the same topics as are used in one-variable calculus within Course Communities. Finally, MIT faculty have designed the new Mathematical Communication site, with lots of help for instructors who want to teach their students about written and oral communication of mathematics. (Received February 15, 2012)

1081-97-407 **Michael E Martin*** (michael.e.martin@gmail.com). *Dynamic Web Tools for Early Undergraduate Mathematics*

This talk features the exhibition and implementation of a large set of dynamic web tools into the primarily early undergraduate math curriculum. The presenter, along with Steve Wilson and Drew Cousino, has developed and utilized a wide array of webMathematica tools for primarily the first two years of undergraduate mathematics courses. These tools have been utilized for a number of years in several courses at JCCC & other institutions. This talk will highlight both the tools and the results in incorporating them for interactive, dynamic learning, exploration, and even drill. The presenter also utilizes WolframAlpha and Wolfram's Demonstrations project in his courses and will relate that to their precursor, webMathematica. The work has been distinguished in receiving the 2004 ICTCM Award for Excellence and Innovation in the Utilization of Technology in Collegiate Mathematics. The tools are freely available to all and accessible over the internet. (Received February 17, 2012)

2010 MATHEMATICS

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