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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
1076	November 29–December 3, 2011	Port Elizabeth, South Africa	EXPIRED	N/A
1077	January 4–7, 2012	Boston, MA	EXPIRED	Vol 33, No. 1
1078	March 3–4, 2012	Honolulu, HI	December 13	Vol 33, No. 2
1079	March 10–11, 2012	Tampa, FL	January 18	Vol 33, No. 2
1080	March 17–18, 2012	Washington, DC	January 31	Vol 33, No. 2
1081	March 30–April 1, 2012	Lawrence, KS	February 14	Vol 33, No. 2
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

ITHACA, NY, September 10–11, 2011

Abstracts of the 1072nd Meeting.

00 ► General

1072-00-266 **S. Dov Gordon*** (ams@dovgordon.com). *Secure Computation.*

Playing chess over the telephone is easy. But what about playing poker? This seems much harder! How do you shuffle the cards? Do you need a trusted party to deal them? How do you know that your opponent has no aces up their sleeve?! Surprisingly, in 1981, Shamir, Rivest and Adleman answered these questions by demonstrating a protocol for playing "mental poker" that does not rely on any trusted party. (They used the same mathematics that appeared in their now-indispensable RSA encryption scheme.) The next year, Andrew Yao generalized the question to arbitrary functions: can two players, each holding private data, interact to compute some function of that data, F(x1, x2), without revealing anything more than the output? He provided an elegant solution, introducing the area of research that we now call "secure computation".

Yao's work was followed by thirty years of research in secure computation. Until recently, this line of work was mainly of theoretical interest. Today, technological advancement is creating both the need for secure computation, and, for the first time, the ability to use it. In this talk we will define secure computation, survey some of the early theoretical results, and describe some of the opportunities and challenges that face the field today. (Received June 29, 2011)

03 ► Mathematical logic and foundations

1072-03-57 **Simon Thomas*** (sthomas@math.rutgers.edu), Mathematics Department, Rutgers University, 110 Frelinghuysen Road, Piscataway, NJ 08854-8019. *The descriptive set theory of unitary group representations.* Preliminary report.

For each countable group G, let $\approx_G$ be the unitary equivalence relation on the space of irreducible unitary representations of G. In this talk, I will consider the question of whether there exist two countable groups G, H

such that:

(i) G, H are not abelian-by-finite; and

(ii) $\approx_G$, $\approx_H$ are not Borel bireducible.

(Received June 14, 2011)

1072-03-74 **Kostyantyn Slutskyy*** (kslutsky@gmail.com), Department of Mathematics, University of Illinois at Urbana-Champaign, 1409 W Green Street, Urbana, IL 61801. *Graev metrics on free products with amalgamation and HNN extensions.*

Starting with a metric space (X,d) one can construct a two-sided invariant metric, called the Graev metric, on the free group F(X) over this space. We give a construction of two-sided invariant metrics on free products (possibly with amalgamation) of groups with two-sided invariant metrics and, under certain conditions, on the HNN extensions. Our approach is similar to the Graev's construction. (Received June 18, 2011)

1072-03-78 **Tomek Bartoszynski***, NSF, Arlington, VA 22230, and **Paul Larson** and **Saharon Shelah**. *On covering of the real line by translations of a compact set.* Preliminary report.

We will discuss what are the necessary and sufficient conditions so that the real line can be (consistently) covered by less than continuum translations of a given compact set (Received June 19, 2011)

1072-03-112 **Arnold W. Miller*** (miller@math.wisc.edu), University of Wisconsin-Madison, Department of Mathematics, Van Vleck Hall, 480 Lincoln Drive, Madison, WI 53706, and **Paul B. Larson**, **Juris Steprāns** and **William A.R. Weiss**. *Universal Functions.* Preliminary report.

For the real line R a function $F : R \times R \to R$ is universal iff for any f of the same type there is $g : R \to R$ such that $f(x, y) = F(g(x), g(y))$ for all $x, y \in R$.

Sierpinski asked in the Scottish book, problem 132, if there exists a Borel function $F(x, y)$ which is universal. He had shown that the answer is yes assuming the continuum hypothesis. If Martin's Axiom is true, then then there is a universal function of Baire class 2. A universal function cannot be of Baire class 1.

Here we show that it is consistent that for each α with $2 < \alpha < \omega_1$ there is a universal function of class α but none of class $\beta < \alpha$. We show that it is consistent with ZFC that there is no universal function Borel or not, and we show that it is consistent that there is a universal function but no Borel universal function. We also prove some results concerning higher order universal functions. (Received June 23, 2011)

1072-03-114 **Clinton T. Conley***, clinton.conley@univie.ac.at. *Canonizing relations on E_0-nonsmooth sets.*

We say that a Borel subset A of Cantor space is E_0-nonsmooth if the restriction of E_0 to A does not admit a Borel transversal, where E_0 is the equivalence relation of eventual agreement. Motivated by Galvin's theorem, we investigate whether a Baire measurable coloring of pairs in Cantor space by finitely many colors admits a homogenous E_0-nonsmooth set. Along the way, we establish a strengthening of the Kanovei-Zapletal canonization of Borel equivalence relations on Cantor space. (Received June 23, 2011)

1072-03-156 **Valentin Ferenczi** and **Christian Rosendal*** (rosendal.math@gmail.com), Mathematics, Statistics and Computer Science, University of Illinois at Chicago, 851 S Morgan St, Chicago, IL 60607. *Isometry groups and maximal symmetry.*

I shall present some recent work on the structure of groups acting by isometries on separable reflexive Banach spaces. In particular, this will treat the so called Fredholm group of small perturbations of scalar multiples of the identity and other small subgroups of the isometry group. This is joint work with V. Ferenczi. (Received June 26, 2011)

1072-03-168 **Aaron T Hill*** (aaronthill@gmail.com). *Centralizers of Rank-1 Homeomorphisms of Zero-dimensional Polish Spaces.*

We define rank-1 homeomorphisms of zero-dimensional Polish space X, analogous in many ways to rank-1 invertible measure-preserving transformations of a standard Lebesgue space. We give necessary and sufficient conditions for a rank-1 homeomorphism to commute only with its integral powers in the group of homeomorphisms of the zero-dimensional Polish space X and discuss connections with the group of invertible measure-preserving transformations. (Received June 27, 2011)

1072-03-172 **Alan Dow***, Department of Mathematics and Statistics, University of North Carolina at Charlotte, 9201 University City Blvd, Charlotte, NC 28223, and **Michael Blackmon**. *Lindelof property in forcing extensions.* Preliminary report.

We explore the general question of when a forcing notion P will preserve the Lindelof property of a space X. The best known results on this topic are that it first arose in Shelah's work on the Lindelof points G_δ question, and that Cohen / random forcing preserves the Lindelof property of every space (Dow / Tall). Of course Souslin forcing destroys the Lindelof property of the corresponding Souslin line. (Received June 27, 2011)

1072-03-173 **Udayan B. Darji*** (ubdarj01@louisville.edu), Department of Mathematics, University of Louisville, Louisville, KY 40292. *Approximation of automorphisms of certain homogeneous structures.*

In this talk we discuss approximations of automorphisms of certain homogeneous structures such as the random graph and the Cantor space. (Received June 27, 2011)

1072-03-202 **Slawomir Solecki***, Department of Mathematics, University of Illinois, Urbana, IL 61801. *Unitary representations of $L_0(\mu, \mathbb{T})$ and of $C^0(K, \mathbb{T})$.*

We give a classification of unitary representations of certain Polish, not necessarily locally compact, groups: groups of all measurable functions with values in the circle and the connected components of the identity of groups of all continuous functions with values in the circle. Essential tools in the proofs are certain known structure theorems and factorization theorems for linear operators. (Received June 28, 2011)

1072-03-212 **Scott Schneider*** (sms252@gmail.com) and **Samuel Coskey**. *Cardinal invariant properties of countable Borel equivalence relations.*

Boykin and Jackson have shown that the bounding number, $\mathfrak{b}$, can be used to define a property of countable Borel equivalence relations that is relevant to the unions problem for hyperfinite relations. In fact, many other cardinal invariants of the continuum can be used in an analogous manner to define "Borel cardinal invariant" properties of countable Borel equivalence relations. In this talk, we introduce these new properties and describe some of the basic relationships that hold between them; in particular, we observe that the property corresponding to the splitting number $\mathfrak{s}$ is equivalent to smoothness. (Received June 28, 2011)

1072-03-267 **Stevo Todorcevic*** (stevo@math.toronto.edu). *Analytic k-gaps.* Preliminary report.

This is a joint work with Antonio Aviles which deals with a particular classification problem for analytic k-gaps in the quotient algebra P(N)/Fin. (Received June 29, 2011)

05 ► Combinatorics

1072-05-5 **Joel Clarke Gibbons*** (jgibbons@logisticresearch.com), 4052 Niles Road, Saint Joseph, MI 49085. *(n+3)-Coloring the n-Sphere.*

We address a combinatorial proposition for the n-sphere and a corresponding proposition in inversive geometry on the n-sphere, and demonstrate the intimate connection between them. Specifically, in terms of combinatorial geometry, we show that any coloring of the n-sphere by n+3 colors must (n+2)-color some (n-1)-sphere. In regard to inversive geometry, we characterize the structure of the class of smallest subsets of the n-sphere that has the property that if T is a well-defined function of the n-sphere that preserves (n-1)-spheres and if the image of T contains a member of this class, T must be an inversive transformation. Lastly, we demonstrate that the combinatorial theorem is equivalent to the theorem that defines this class of sets. (Received March 18, 2011)

1072-05-33 **T. Kyle Petersen*** (tpeter21@depaul.edu), 2320 N. Kenmore, Chicago, IL 60614, and **Marcelo Aguiar**, Department of Mathematics, College Station, TX 77843. *The module of affine descents.*

We use the notion of affine descent sets to describe a module over Solomon's descent algebra. The approach is geometric; while the geometry of the Coxeter complex can be used to describe Solomon's descent algebra, this module arises from the geometry of the Steinberg torus. (Received May 27, 2011)

1072-05-82 **Jacob Anthony White*** (uaswitch@gmail.com). *Hopf Monoids in Graphical Species.*

We investigate monoidal structures on the category of graphical species. Graphical species are functors from the category of graphs (with isomorphisms) to the category of vector spaces over a fixed field. We focus on studying 'graphical analogues' of results for Hopf monoids in species. For this talk, we will focus on some basic examples, while showing new structures that arise in graphical species. (Received June 20, 2011)

1072-05-124 **Nathan Reading*** (nathan_reading@ncsu.edu). *Generic rectangulations and pattern-avoiding permutations.*

A rectangulation is a tiling of a rectangle by rectangles. The rectangulation is called generic if no four of its rectangles share a corner. We will consider the problem of counting generic rectangulations (with n rectangles) up to combinatorial equivalence. This talk will present and explain an initial step in the enumeration: the fact that generic rectangulations are in bijection with permutations that avoid a certain set of patterns. I will give background information on rectangulations and pattern avoidance. Then I will make the connection between generic rectangulations and pattern avoiding permutations, which draws on earlier work with Shirley Law on "diagonal" rectangulations. I will also explain how this result relates to combinatorial Hopf algebras and to the lattice theory of the weak order on permutations. (Received June 24, 2011)

1072-05-140 **Marcelo Aguiar**, **Louis Billera** and **Caroline Klivans*** (cjk@math.uchicago.edu). *A quasisymmetric function for generalized permutahedra.*

Given a generalized permutahedron, we associate both a quasisymmetric function and a simplicial complex. We prove positivity of the quasisymmetric function in the fundamental basis and positivity of the h-vector of the complex. Further we explore the relationship between these two collections extending a result of Steingrimmson to arbitrary subcomplexes of the Coxeter complex. Our framework includes Stanley's chromatic quasisymmetric function, Steingrimsson's coloring complex, and the Billera-Jia-Reiner quasisymmetric function all as special instances. (Received June 25, 2011)

1072-05-174 **Marcelo Aguiar** and **Aaron Lauve*** (lauve@math.luc.edu). *Lagrange's Theorem for Hopf Monoids in Species.*

Following Radford's proof of Lagrange's theorem for pointed Hopf algebras, we prove Lagrange's theorem for Hopf monoids in the category of connected species. As a corollary, we obtain necessary conditions for a given subspecies $\mathbf{k}$ of a Hopf monoid $\mathbf{h}$ to be a Hopf submonoid: the quotient of any one of the generating series of $\mathbf{h}$ by the corresponding generating series of $\mathbf{k}$ must have nonnegative coefficients. We highlight two further corollaries as time permits, necessary conditions for a sequence of nonnegative integers to be the sequence of dimensions of: (i) a Hopf monoid (these take the form of certain polynomial inequalities); (ii) a set-theoretic Hopf monoid (the binomial transform of the sequence must be nonnegative). (Received June 27, 2011)

1072-05-183 **Erin Elizabeth Bancroft*** (erinluke@hotmail.com). *The Shard Intersection Order on Permutations.*

The shard intersection order is a new lattice structure on a finite Coxeter group W which encodes the geometry of the reflection arrangement and the lattice theory of the weak order. It also contains the noncrossing partition lattice as a sublattice. In the case where W is the symmetric group, we characterize shard intersections as certain pre-orders which we call permutation pre-orders. We use this combinatorial characterization to determine properties of the shard intersection order. In particular, we give an EL-labeling. (Received June 27, 2011)

1072-05-191 **Shirley E. Law*** (selaw@ncsu.edu). *The Hopf Algebra of Sashes.*

A general lattice theoretic construction of Reading constructs sub Hopf algebras of the Malvetuto-Reutenauer Hopf algebra (MR) of permutations. The products and coproducts in these sub Hopf algebras are defined extrinsically in terms of the embedding in MR. The goal of this research is to find an intrinsic combinatorial description of a particular one of these sub Hopf algebras. The Hopf algebra in question has a natural basis given by permutations that I call Pell permutations because they are counted by the Pell numbers, which are defined by a recurrence similar to the Fibonacci recurrence. Additionally, the Pell numbers count a combinatorial object that I call a sash, which is a tiling of a 1 by n rectangle with three types of tiles: black 1 by 1 squares, white 1 by 1 squares, and white 1 by 2 rectangles.

I will describe a bijection between Pell permutations and sashes, an intrinsic description of the product in terms of sashes, and the natural partial order on sashes. I am currently working on an intrinsic description of the coproduct. (Received June 27, 2011)

1072-05-218 **Forest Fisher*** (fdf28@email.vccs.edu), 6901 Sudley Road, Manassas, VA 20109-2399. *A Rigidity theorem for connected, cocommutative Hopf monoids.* Preliminary report.

A Hopf algebra is coZinbiel whenever its coproduct can be written as the sum of two non-coassociative coproducts satisfying certain compatibility conditions. Aguiar and Mahajan have shown that connected, cocommutative Hopf monoids give rise to a family of Hopf algebras which are always (i) free as algebras and (ii) coZinbiel. We use these two properties to prove a rigidity theorem for all such Hopf algebras. In particular, we define a sequence of endomorphisms ${}_1\beta$, ${}_2\beta$, ${}_3\beta, \ldots$ that map into the subspace of primitive elements and are intimately related

to the Dynkin idempotent. We will show that the map ${}_1\beta$ projects onto the subspace of "total primitives" and provides a set of generators for the free Lie algebra of primitive elements. (Received June 28, 2011)

1072-05-227 **Stefan Forcey*** (sf34@uakron.edu), **Aaron Lauve** and **Frank Sottile**. *Composing species and composing coalgebras.*

We develop the notion of the composition of two coalgebras, which arises naturally in higher category theory and the theory of species. We prove that the composition of two cofree coalgebras is cofree and give conditions which imply that the composition is a one-sided Hopf algebra. These conditions hold when one coalgebra is a graded Hopf operad $\mathcal{D}$ and the other is a connected graded coalgebra with coalgebra map to $\mathcal{D}$. We conclude with examples of these structures, where the factor coalgebras have bases indexed by the vertices of multiplihedra, composihedra, and hypercubes. (Received June 28, 2011)

1072-05-268 **Tom Halverson*** (halverson@macalester.edu), Macalester College, Saint Paul, MN 55105. *Schur-Weyl Duality for Complex Reflection Groups.* Preliminary report.

For a complex reflection group G defined on a n-dimensional $\mathbb{C}$-vector space V we consider the space $\mathsf{End}_G(V^{\otimes k}) = \mathsf{Hom}_G(V^{\otimes k}, V^{\otimes k})$ of endomorphisms that commute with G on the k-fold tensor product $V^{\otimes k}$. The algebra $\mathsf{End}_G(V^{\otimes k})$ is a semisimple matrix algebra that is in "Schur-Weyl duality" with G. When G is the symmetric group S_n, and V is its permutation representation, $\mathsf{End}_G(V^{\otimes k})$ is the partition algebra with a basis labeled by the set partitions of $\{1, \ldots, 2k\}$. We examine the extension of this idea to other complex reflection groups. For example, when $G = G(r, p, n)$, in Shepard-Todd notation, $\mathsf{End}_G(V^{\otimes k})$ is the Tanabe partition algebra $A_k(r, p, n)$. If $\dim(V) = 2$ and G is a finite subgroup of $\mathsf{SU}(2)$, then $\mathsf{End}_G(V^{\otimes k})$ can be studied, via the McKay correspondence, using the combinatorics of the affine (extended) Dynkin diagrams of type ADE. (Received June 29, 2011)

08 ► General algebraic systems

1072-08-170 **Nantel Bergeron*** (bergeron@yorku.ca), Dept. of Math.and Stat., York University, 4700 Keele st, Toronto, Ontario M3J 1P3, Canada, and **Marcelo Aguiar** and **Nathaiel Thiem**. *Why a supercharacter theoretic Hopf Monoid of set partitions?*

In his talk, Nat Thiem introduced the supercharacter theory of the finite groups of unipotent uppertriangular matrices and the associated Hopf monoid of supercharacters. Why would one do such a thing? To convince ourselves that this is interesting work, I will show that at the Hopf monoid level the formulas for the antipode and primitive elements are much more elegant than their Hopf algebraic counterparts. Additionally, since Hopf monoid gives rise to many Hopf algebras, in some cases, we get the analogous results in the Hopf algebras for free, shedding a new light on Hopf algebra results. In particular, we can show that the antipode is triangular on the supercharacter basis, which is a phenomenon observed but left open during the AIM workshop on supercharacter theory and combinatorial Hopf algebras (see ArXiv:1009.4134). (Received June 27, 2011)

11 ► Number theory

1072-11-101 **Lei Zhang*** (zhang423@umn.edu). *Automorphic Forms on Certain Symplectic Pairs.* Preliminary report.

In this talk, we consider automorphic periods associated to the symmetric pairs $(\mathrm{Sp}_{4n}, \mathrm{Res}_{K/k}\mathrm{Sp}_{2n})$ and $(\mathrm{GSp}_{4n}, \mathrm{Res}_{K/k}\mathrm{GSp}_{2n})$, where k is a number field and K is an Étale algebra over k of dimension 2. We consider the period integral of a cusp forms of $\mathrm{Sp}_{4n}(\mathbb{A}_k)$ against with an Eisenstein series of the symmetric subgroup $\mathrm{Res}_{K/k}\mathrm{Sp}_{2n}$, and expect to establish an identity between this period integrals and the special value of L-functions.

In the local theory, using Aizenbud and Gourevitch's generalized Harish-Chandra method and the Gelfand-Kahzdan theorem, we can prove that these symmetric pairs are Gelfand pairs when K_v is a quadratic extension field over k_v for any n, or K_v is isomorphic to $k_v \times k_v$ for $n \leq 2$. Furthermore, according to the Yu' construction of irreducible tame supercuspidal representations and the dimension formula given by Hakim and Murnaghan, we give sufficient and necessary conditions of generic cuspidal data such that the corresponding tame supercuspidal representations are H-distinguished, for the symmetric pair $(\mathrm{Sp}_{4n}(k_v), \mathrm{Sp}_{2n}(K_v))$. (Received June 22, 2011)

1072-11-143 **Hafedh Herichi** and **Michel L. Lapidus*** (lapidus@math.ucr.edu), Department of Mathematics, 231 Surge Bdg., Riverside, CA 92521-0135. *Spectra of Fractal Strings and Riemann Zeros.*

We will provide a precise functional analytic framework for studying the spectral operator, acting on the class of generalized fractal strings of a given dimension, as introduced semi-heuristically by M. van Frankenhuijsen and the presenter in their 2006 Springer research monograph "Fractal Geometry, Complex Dimensions and Zeta Functions" (Sect. 6.3.2). After having expressed the spectral operator as a function of the infinitesimal shift of the real line, we will exactly determine its spectrum, and show that for a given dimension D in the critical interval (0.1), the spectral operator is invertible if and only if the Riemann zeta function does not have any zeros on the vertical line Re(s)=D. It follows that the Riemann hypothesis is true if and only if the spectral operator is invertible in every dimension other than the mid-fractal one, D=1/2. If time permits, we will also discuss related results of the authors concerning an operator-valued Euler representation of the spectral operator, as well as a localized version of the spectral operator recently obtained by the author. (Received June 26, 2011)

1072-11-146 **Cesar Valverde*** (cvalverd@rutgers.edu). *A generalization of a result of Kohnen.*

Let f and g be Hecke eigenforms of weights $2k$ and $k+1/2$ related via Shimura correspondence. Kohnen has proved an equality relating a period integral of f to a Fourier coefficient of g. Work of Waldspurger implies that the square of this period of f is related to the value at $1/2$ of the base change L-series attached to f. We propose a generalization of these results to higher rank. The result will follow from a comparison between geometric sides of the Relative Trace Formula on GL_{2n} and $\widetilde{Sp_n}$. (Received June 26, 2011)

1072-11-175 **Peter J Grabner*** (peter.grabner@tugraz.at), Institut für Analysis und Comp. N. Th, Steyrergasse 30, Graz, 8010. *Fractal measures originating from number theory.*

Let $(X_n)_{n\in\mathbf{N}}$ be a sequence of independent random variables taking values 0 and 1 with equal probability. Erdős in 1939 studied the distribution of the series

$$\sum_{n=1}^{\infty} X_n \beta^{-n}$$

and showed that it is singular continuous, if β is a Pisot number less than 2. On the other hand B. Solomyak showed in 1995 that the measure is absolutely continuous for almost all $\beta \in (1,2)$.

Recently, similar measures were encountered in the context of redundant numeration, for instance in counting the number of base 2 representations of integers using the digits $\{0,\pm 1\}$ with minimal number of non-zero digits. This leads to a generalisation, where the digits are no more independent, but are governed by a Markov chain. We give an overview over these results. (Received June 29, 2011)

1072-11-274 **Terry Gannon*** (tgannon@math.ualberta.ca), Edmonton, Alberta T6G 2G1, Canada. *Vector-valued modular forms and the Riemann-Hilbert problem.*

An effective theory, including Riemann-Roch, is presented for the vector-valued modular forms for arbitrary representations of arbitrary genus-0 Fuchsian groups. Applications to vertex operator algebras, both rational and logarithmic, are discussed. (Received June 30, 2011)

14 ► Algebraic geometry

1072-14-206 **Mboyo Esole*** (esole@math.harvard.edu), Department of Mathematics, Harvard University, 1 Oxford Street, Cambridge, MA 02138. *Small resolutions of SU(5) models in F-theory.*

We provide an explicit desingularization and study the resulting fiber geometry of elliptically fibered (Calabi-Yau) fourfolds defined by a Weierstrass model admitting a split $\tilde{A}_4$ singularity over a divisor of the discriminant locus. Such varieties are used to geometrically engineer SU(5) Grand Unified Theories in F-theory. We also discuss several transitions between different resolutions and their physical meaning. (Received June 28, 2011)

15 ► Linear and multilinear algebra; matrix theory

1072-15-84 **Sam Northshield*** (northssw@plattsburgh.edu). *Some iterative root-finding methods arising from matrices.*

Newton's method is generally convergent for quadratic polynomials; it converges rapidly to a root of az^2+bz+c for almost all starting points and almost all coefficients a,b,c. This can be understood in terms of an associative

binary operation arising from 2×2 matrices. Here we develop an analogous theory based on $n \times n$ matrices. Newton's method is not generally convergent for cubic polynomials but McMullen found a one-variable algorithm that is (and showed that no such algorithm exists for higher degree polynomials). When $n = 3$, our method yields a two-variable generally convergent algorithm for cubics which, in certain cases, "contains" McMullen's algorithm. (Received June 20, 2011)

17 ► Nonassociative rings and algebras

1072-17-10 **Igor Kriz*** (ikriz@umich.edu), Department of Mathematics, University of Michigan, 2074 East Hall, 530 Church Street, Ann Arbor, MI 48109-1043. *An algebraic approach to genus 0 chiral conformal field theory.*

I will report on an approach to making chiral conformal field theory in genus 0 into a fully algebraic object. First, I will discuss a new axiomatization of vertex algebras using graded co-operads in the category of vector spaces, following my joint paper with Ruthi Hortsch and Ales Pultr. Using this axiomatization, I will describe an algebraic axiomatization of genus 0 intertwining vertex operators (which are typically transcendental) via regular algebraic flat connections, following my joint paper with Yang Xiu. I will also talk about interface, via the Riemann-Hilbert correspondence, with previous work by Yi-Zhi Huang, James Lepowsky and others, who used approaches involving both algebra and analysis. (Received April 29, 2011)

1072-17-13 **Liang Kong*** (kong.fan.liang@gmail.com), Institute for Advanced Study (Science Hall), Tsinghua University, Beijing, 100084, Peoples Rep of China. *Conformal field theory and a new geometry.* Preliminary report.

I will start with a discussion on the impact of string theory on our understanding of geometry from a single angle, and then argue that conformal field theories (CFT) provide an entirely new algebraic geometry. Then I will review the vertex-operator-algebra approach towards open-closed CFT. In the rational cases, I will show that open-closed CFTs satisfying a strong boundary condition can be classified. Using this classification, I will discuss some basic properties of the new geometry such as Holographic Principle and a precise relation between dualities and invertible defects. (Received May 10, 2011)

1072-17-46 **Yi-Zhi Huang*** (yzhuang@math.rutgers.edu), Department of Mathematics, Rutgers University, 11) Frelinghuysen Road, Piscataway, NJ 08854. *Deformation theory of grading-restricted vertex algebras.* Preliminary report.

I will present a deformation theory of grading-restricted vertex algebras. Motivations for this deformation theory are from the studies of quantization and Calabi-Yau manifolds. This deformation theory is described by suitable second and third cohomologies of these vertex algebras introduced by me in 2010: An infinitesimal deformation of a grading-restricted vertex algebra is given by a second cohomology class and the obstruction for a formal deformation with a given infinitesimal deformation is a sequence of third cohomology classes. (Received June 11, 2011)

1072-17-58 **Geoffrey Mason***, Department of Mathematics, UC Santa Cruz, Santa Cruz, CA 95064. *Structure of rational vertex operator algebras - reviving the conformal bootstrap.* Preliminary report.

We discuss the algebraic structure of strongly regular vertex operator algebras. (Received June 14, 2011)

1072-17-71 **Kailash C. Misra*** (misra@ncsu.edu), Department of Mathematics, North Carolina State University, Raleigh, NC 27695-8205, and **Rebecca L. Jayne**. *On Demazure crystals for* $U_q(G_2^{(1)})$.

We consider the quantum affine algebra $U_q(G_2^{(1)})$ and its irreducible level l modules $V(l\Lambda_0)$ and $V(l\Lambda_2)$. The associated crystals $B(l\Lambda_0)$ and $B(l\Lambda_2)$ can be realized as certain sequences (paths)in the semi-infinite tensor product of the level l perfect crystal $B = B^{1,l}$. Let W be the Weyl group and for $w \in W$, let $V_w(l\Lambda_0)$ and $V_w(l\Lambda_2)$ be the corresponding Demazure modules. The associated crystals $B_w(l\Lambda_0)$ and $B_w(l\Lambda_2)$ are certain subsets of the crystals $B(l\Lambda_0)$ and $B(l\Lambda_2)$ respectively. We show that there exist suitable sequences $\{w^{(k)}\}_{k\geq 0}$ and $\{w'^{(k)}\}_{k\geq 0}$ of Weyl group elements such that the Demazure crystals $B_{w^{(k)}}(l\Lambda_0)$ and $B_{w'^{(k)}}(l\Lambda_2)$ have tensor product like structures. (Received June 17, 2011)

1072-17-118 **Marco Aldi***, aldi@brandeis.edu, and **Reimundo Heluani**. *Dilogarithms, OPE and twisted T-duality.*

We present a new method for the full quantization of the bosonic sigma-model with target a (possibly) twisted nilmanifold. The resulting algebraic structure governing field interactions is a generalization of the notion of lattice vertex algebra. The main novelty is the presence of dilogarthmic singularities in the basic OPEs. We explain the role of T-duality and we show how the factorization structure of the correlators naturally encodes the most basic functional equations satisfied by the dilogarithm. (Received June 23, 2011)

1072-17-125 **Scott Carnahan*** (scott.carnahan@ipmu.jp), IPMU, 5-1-5 Kashiwanoha, Kashiwa, Chiba 277-8583, Japan. *Conformal blocks on nodal curves.*

Frenkel and Ben-Zvi gave a method for attaching a space of conformal blocks to the data of a smooth complex algebraic curve, a quasi-conformal vertex algebra, and modules placed at points. Furthermore, when the vertex algebra has conformal structure, one obtains sheaves of conformal blocks with projectively flat connection on moduli spaces of smooth curves with marked points. I'll describe how logarithmic geometry can be employed to canonically extend these sheaves to the semistable locus, where the connection acquires at most logarithmic singularities. When one has a finite group G acting by automorphisms of the conformal vertex algebra, one may construct equivariant intertwining operators by varying ramified G-covers of the projective line. (Received June 24, 2011)

1072-17-127 **Thomas Robinson*** (thomasro@math.rutgers.edu), 110 Frelinghuysen Rd, Piscataway, NJ 08854. *A classical vertex algebra constructed with the use of some logarithmic formal calculus.*

Using some new logarithmic formal calculus, we construct a well known vertex algebra, obtaining the Jacobi identity directly, in an essentially self-contained treatment. (Received June 24, 2011)

1072-17-141 **Drazen Adamovic** (adamovic@math.hr), Faculty of Science, Department of Mathematics, Bijenicka cesta 30, Zagreb, Croatia, and **Ozren Perse*** (perse@math.hr), Faculty of Science, Department of Mathematics, Bijenicka cesta 30, Zagreb, Croatia. *Conformal embeddings of affine vertex operator algebras.*

Conformal embeddings have been extensively studied in conformal field theory, the representation theory of affine Kac-Moody algebras and the theory of affine vertex operator algebras. The construction and classification of conformal embeddings have mostly been studied in the case of positive integer levels. In this talk, we present a general criterion for conformal embeddings at arbitrary levels, within the framework of vertex operator algebra theory. Using that criterion, we construct new conformal embeddings at admissible rational and negative integer levels. In particular, we construct all remaining conformal embeddings associated to automorphisms of Dynkin diagrams of simple Lie algebras. (Received June 26, 2011)

1072-17-166 **Drazen Adamovic*** (adamovic@math.hr), Department of Mathematics, University of Zagreb, Bijenicka 30, 10 000 Zagreb, Croatia, and **Antun Milas** (amilas@math.albany.edu). *On explicit realization of logarithmic modules for certain vertex algebras.*

We review our recent results on the representation theory of triplet W-algebras associated to (1,p) and (2,p) minimal models for the Virasoro algebra. We discuss the existence and construction of logarithmic modules for these vertex algebras. A related realization of certain logarithmic modules for admissible affine vertex operator algebras will be also presented. (Received June 27, 2011)

1072-17-179 **Elizabeth Jurisich*** (jurisiche@cofc.edu), Mathematics Department, The College of Charleston, 66 George Street, Charleston, SC 29424, and **Ben Cox** (coxbl@cofc.edu). *A free field type representation of elliptic G_2.* Preliminary report.

We present a free field type representation of an elliptic algebra constructed from the simple Lie algebra G_2. (Received June 27, 2011)

1072-17-182 **Ben Cox***, 66 George Street, Dept. of Mathematics, The College of Charleston, Charleston, SC 2946, and **Xiangqian Guo**, **Rencai Lu** and **Kaiming Zhao**. *N-point Virasoro algebras and their modules of densities.*

In this talk we introduce and describe what we call the n-point Virasoro algebra which is a natural generalization of the classical Virasoro algebra and is the universal central extension of the multipoint genus zero Krichever-Novikov type algebra. We determine the necessary and sufficient conditions for such algebras to be isomorphic, their automorphisms, their derivation algebras, their universal central extensions, and some other properties. In particular we find that the automorphism group is either the trivial group or one of the five finite subgroups of

$SU(2,\mathbb{C})$: C_n, D_n, A_4, S_4 or A_5. We give examples showing that each of these groups occurs. We also construct a large class of modules which we call dense modules, and determine the necessary and sufficient conditions for them to be irreducible. (Received June 27, 2011)

1072-17-208 **Katrina D. Barron*** (kbarron@nd.edu), Department of Mathematics, 255 Hurley Hall, University of Notre Dame, Notre Dame, IN 46556. *Supersymmetric vertex operator superalgebras and twisted constructions arising in superconformal field theory.*

We will discuss some twisted and untwisted modules for certain supersymmetric vertex operator superalgebras. These modules naturally arise for instance when constructing genus-one and higher-genus superconformal correlation functions. (Received June 28, 2011)

1072-17-228 **Quincy Loney*** (quincy.loney@cortland.edu) and **Alex J Feingold** (alex@math.binghamton.edu). *Decomposition of level-1 representations of $D_4^{(1)}$ with respect to its subalgebra $G_2^{(1)}$ in the spinor construction.* Preliminary report.

Feingold, Frenkel, Ries (1991) gave a spinor construction of the vertex operator para-algebra $V = V^0+V^1+V^2+V^3$, whose summands are 4 level-1 irreps of $D_4^{(1)}$. The triality group $S_3 =< \sigma, \tau >$ in $Aut(V)$ was constructed, preserving V^0 and permuting V^i, $i = 1, 2, 3$. V is $Z/2$-graded and V_n^i denotes the n-graded subspace of V^i. Vertex operators $Y(v, z)$ for $v \in V_1^0$ represent $D_4^{(1)}$ on V, while those for which $\sigma(v) = v$ represent $G_2^{(1)}$. V decomposes into $G_2^{(1)}$ irreps, first decomposing with respect to the intermediate algebra $B_3^{(1)}$ represented by $Y(v, z)$ for $\tau(v) = v$. There are three vectors, $w_i \in V_2^0$ such that $Y(w_i, z)$ represents the Virasoro algebra (Sugawara construction) from the three algebras D_4, B_3, G_2. These give two commuting coset Virasoro constructions from $w_1 - w_2$ and $w_2 - w_3$, with $c = 1/2$ and $c = 7/10$, resp., the first commuting with $B_3^{(1)}$, the second commuting with $G_2^{(1)}$. This gives the space of highest weight vectors for $G_2^{(1)}$ in V as tensor products of irreducible Vir modules $L(1/2, h_1) \otimes L(7/10, h_2)$. (Received June 28, 2011)

1072-17-236 **Jonathan Axtell***, axtell@math.uconn.edu, and **Kyu-Hwan Lee**, khlee@math.uconn.edu. *Vertex Operator Algebras Associated to Type G Affine Lie Algebras.*

The admissible representations of an affine Lie algebra are analogues of integrable representations at fractional integer levels. They were first introduced by Kac-Wakimoto in their study of modular invariant representations of affine Lie algebras. In this talk, we consider vertex operator algebras (VOA) associated with admissible modules for a type G affine Lie algebra at certain admissible one-third integer levels. We give formulas for the singular vectors and discuss how these are used to classify irreducible representations. In particular, we verify a conjecture of Adamovic and Milas which states that such VOA are "rational in the category $\mathcal{O}$". (Received June 28, 2011)

18 ► Category theory; homological algebra

1072-18-176 **Mark W. Johnson*** (mwj3@psu.edu), Penn State Altoona, Ivyside Park, Altoona, PA 16601-3760. *Deconstructing Waldhausen's $S_\bullet$ construction.* Preliminary report.

By writing Waldhausen's $S_\bullet$ construction as a series of steps, it is possible to address naive questions such as "why are quotients even involved in defining d_0?" and "why so much care with these choices of quotients?". The key observation here is that d_0 arises as a left adjoint to s_0. In fact, this left adjointness leads to the appearance of quotients and suffices to imply that each of the simplicial identities involving d_0 holds up to a natural isomorphism. As a consequence, one must apply a straightforward rectification functor to make the simplicial identities hold on the nose, which is reconstructible from Waldhausen's choices of quotients. Various implications will be presented. (Received June 27, 2011)

20 ► Group theory and generalizations

1072-20-26 **Sorin Dascalescu**, Str Academiei nr 14, 010014 Bucharest, Romania, **Miodrag C Iovanov*** (iovanov@usc.edu), 3610 S Vermont St KAP108, Los Angeles, CA 90004, and **Constantin Nastasescu**, Bucharest, Romania. *Compact Quantum Groups Arising from Quivers.*

A problem of central interest in combinatorial Hopf algebras is to find Hopf algebra structures on quiver algebras and coalgebras. At the same time, an important class of quantum groups are those having a non-zero integral.

They are precisely those whose category of comodules is Frobenius (injectives=projectives). These generalize the compact groups: the (Hopf) algebra of representative functions on a topological compact group has a non-zero integral given by restricting the Haar integral. We show that quiver or PO-set coalgebras with this property - the so called co-Frobenius coalgebras - must be co-semisimple. We thus turn attention to more general objects: pointed coalgebras which have a basis of paths in some quiver coalgebra. This situation dualizes that of quiver algebras modulo monomial relations, and, in fact, recovers at least the finite dimensional such algebras. We classify such co-Frobenius coalgebras and show connections to (q-)Homological Algebra. We then classify the above mentioned pointed "monomial" Hopf algebras with nonzero integral (compact quantum groups). We also show how these arise form a different direction: serial Hopf algebras, and we find a unifying approach between their representation theory and the theory of infinite abelian groups. (Received May 23, 2011)

1072-20-66 **G. Arzhantseva** and **J.-F. Lafont*** (jlafont@math.ohio-state.edu). *Isomorphism vs. commensurability for certain classes of groups.*

We will give constructions for two classes of groups. Within the first class of groups, the isomorphism problem is solvable, but the commensurability problem is unsolvable. Within the second class of groups, the commensurability problem is solvable, but the isomorphism problem is unsolvable. Various open problems will be suggested. This is joint work with G. Arzhantseva. (Received June 16, 2011)

1072-20-76 **Daniel Groves**, **Jason Fox Manning*** (j399m@buffalo.edu) and **Henry Wilton**. *Recognizing 3-manifold groups.*

I will discuss some results related to the problem of recognizing 3-manifold groups among finitely presented groups. This is joint work with Daniel Groves and Henry Wilton. (Received June 19, 2011)

1072-20-87 **Lisa Carbone*** (carbonel@math.rutgers.edu), **Alex Feingold** (alex@math.binghamton.edu) and **Walter Freyn** (walter.freyn@uni-muenster.de). *A lightcone construction of the Tits buildings of a rank 2 hyperbolic Kac-Moody group.* Preliminary report.

We describe a construction of a one-parameter family of embeddings of the twin Tits building of a rank 2 hyperbolic Kac-Moody group over C into the corresponding rank 2 hyperbolic Kac-Moody algebra. When the embedding parameter equals zero, the twin Tits building is embedded into the light cone of the Kac-Moody algebra. (Received June 21, 2011)

1072-20-100 **Pallavi Dani*** (pdani@math.lsu.edu) and **Anne Thomas**. *Divergence in right-angled Coxeter groups.*

The divergence of a pair of geodesics emanating from a point in a metric space is a measure of how quickly they are moving away from each other. Gersten used this idea to define a quasi-isometry invariant for groups. I will talk about joint work with Anne Thomas on divergence in the class of right-angled Coxeter groups. (Received June 22, 2011)

1072-20-103 **David Garber*** (garber@hit.ac.il), 52 Golomb st., P.O.Box 305, 58102 Holon, Israel, and **Arkadius Kalka**, **Boaz Tsaban** and **Gary Vinokur**. *Super Summit Sets for the Multiple Conjugacy Problem in braid groups.* Preliminary report.

Let $v = (a_1, \ldots, a_n), w = (b_1, \ldots, b_n)$ be n-tuples of braids. The Multiple Conjugacy Problem (MCP) is that of deciding whether there is a braid x such that for each $i = 1, \ldots, n$, $xa_ix^{-1} = b_i$.

Lee and Lee (2002) defined a finite invariant subset of the cojugacy class of such vectors v, and proposed an algorithm for computing it, thus finding a finite time solution to the MCP. Gonzalez-Meneses (2005) presented a substantial improvement of this algorithm, but the invariant set is still too large. In the single conjugacy problem case, Lee-Lee's invariant set is larger than Garside's Summit Sets, and much larger than El-Rifai and Morton's (1994) Super Summit Set (SSS).

We introduce a much smaller invariant set, the Multiple Super Summit Set (MSSS), which is exactly the SSS in the single conjugacy problem case. The size of our MSSS tends to be a small constant, when n is just a constant multiple of the braid index. We supply an efficient way to compute the MSSS, using a generalization of Meneses's method of minimal elements. Our methods generalize to Garside groups as well.

The MSSS yields an efficient cryptanalysis of the Ko et al. cryptosystem (2000). We are considering its potential applicability to Shpilrain-Ushakov's cryptosystem (2006). (Received June 23, 2011)

1072-20-132 **Marcelo Aguiar**, **Nantel Bergeron** and **Nathaniel Thiem***, Department of Mathematics, Campus Box 395, Boulder, CO 80309. *A supercharacter theoretic Hopf Monoid of set partitions.* Preliminary report.

The representation theory of the symmetric group gives an algebraic interpretation of the Hopf algebra of symmetric functions and its integer partition combinatorics. Similarly, supercharacters of the finite groups unipotent uppertriangular matrices give a representation theoretic foundation for the Hopf algebra of symmetric functions in noncommuting variables with its set partition combinatorics. However, in the process of working with these supercharacters, it quickly becomes clear that the category of Hopf monoids is an even more natural setting for this theory. This talk will introduce the Hopf monoid of supercharacters, and give some generalizations to other similar representation theoretic monoids. (Received June 24, 2011)

1072-20-149 **Bogdan Ion*** (bion@pitt.edu), PA. *A series of unitary representations of the quantum SU(1,1).*

Unlike the case of compact quantum groups, the representation theory of non-compact quantum groups is still unexplored. I will present the construction of a series of unitary representations of the simplest non-compact quantum group. The results are q-versions of corresponding constructions for the simply-connected cover of SL(2,R) (due to Kostant). (Received June 26, 2011)

1072-20-150 **Dave Witte Morris*** (Dave.Morris@uleth.ca). *Survey of invariant orders on arithmetic groups.* Preliminary report.

At present, there are more questions than answers about the existence of an invariant order on an arithmetic group. (By "order," we mean a transitive binary relation $\prec$, such that $x \prec y \Rightarrow y \not\prec x$.) We will discuss four different versions of the problem: the order may be required to be total, or allowed to be only partial, and the order may be required to be invariant under multiplication on both sides, or only on one side. One version is trivial, but the other three are related to interesting conjectures in the theory of arithmetic groups. (Received June 26, 2011)

1072-20-153 **Lucas Sabalka*** (sabalka@math.binghamton.edu) and **Dmytro Savchuk** (dsavchuk@math.binghamton.edu). *On restricting free factors in relatively free groups.*

Let G be a free, free nilpotent, or free metabilian group, and let $A = \{a_1, ..., a_n\}$ be a basis for G. We will show that in many cases, if S is a subset of a basis for G which may be expressed without the element an, then S is a subset of a basis for the relatively free group on $A - \{a_n\}$. (Received June 26, 2011)

1072-20-157 **Robert J Young*** (ryoung@utsc.utoronto.ca), Robert Young, University of Toronto at Scarborough, 1265 Military Trail Rm. IC477, Toronto, Ontario M1C 1A4, Canada. *The Dehn function of SL$(n;\mathbb{Z})$.*

The Dehn function is a group invariant which connects geometric and combinatorial group theory; it measures both the difficulty of the word problem and the area necessary to fill a closed curve in an associated space with a disc. The behavior of the Dehn function for high-rank lattices in high-rank symmetric spaces has long been an open question; one particularly interesting case is SL$(n;\mathbb{Z})$. Thurston conjectured that SL$(n;\mathbb{Z})$ has a quadratic Dehn function when $n \geq 4$. This differs from the behavior for $n = 2$ (when the Dehn function is linear) and for $n = 3$ (when it is exponential). I have proved Thurston's conjecture when $n \geq 5$, and in this talk, I will give an introduction to the Dehn function, discuss some of the background of the problem and give a sketch of the proof. (Received June 26, 2011)

1072-20-167 **Curtis Kent*** (curt.kent@vanderbilt.edu). *Local homotopy properties of asymptotic cones of groups.*

An asymptotic cone of a group is a metric space which encodes the large scale geometry of a group. In '91, Gromov asked what groups arise as fundamental groups of asymptotic cones of finitely generated groups. By examining the local fundamental groups of asymptotic cones of multiple HNN extensions of free groups, we will show that an asymptotic cone of a group from this class has fundamental group which is trivial or uncountable. 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 June 27, 2011)

1072-20-193 **Adam Piggott*** (adam.piggott@bucknell.edu), Department of Mathematics, Bucknell Universit, Lewisburg, PA 17837. *The automorphisms of McCullough-Miller space.* Preliminary report.

McCullough-Miller's space X=X(W) is a topological model for a certain subgroup of the outer automorphism group of a free product of groups W. We will discuss the question of just how well X models $Out(W)$. In particular, we consider circumstances under which Aut(X) is precisely $Out(W)$. (Received June 27, 2011)

1072-20-195 **Charalambos M Koupparis*** (ckoupparis@gc.cuny.edu), NY, and **Delaram Kahrobaei** and **Vladimir Shpilrain**. *Public Key Exchange Using Matrices Over Group Rings.*

We propose to look at the Diffie-Hellman key exchange protocol using matrices over group rings. In order to determine the validity and security of this scheme the Decision Diffie-Hellman (DDH) and Computational Diffie-Hellman (CDH) problems will be addressed. We will be working with matrices defined over group rings $\mathbb{Z}_m[S_n]$, and specifically $\mathbb{Z}_2[S_5]$.
(Received June 27, 2011)

1072-20-199 **Gabriel Zapata*** (nyzapata@gmail.com), New York, NY 10016. *Naturality in Public-Key Cryptography.* Preliminary report.

Practical public-key cryptosystems rely on the commutativity of their platforms. The commutative platform induces protocols that are designed to utilize the commutative property. On the other hand, theoretical non-commutative public-key cryptography aims at avoiding the dependence in the commutativity of the algebraic platform in hopes of developing protocols that are also free from commutativity. However, the protocol suggested by Anshel, M. Anshel and D. Goldfeld, et al., is the only known protocol to successfully avoid commutativity in both the platform and in the theoretical construction of the protocol. Here we develop a general method of choosing a non-commutative platform that avoids commutativity in the design of the protocol and that differs from the Anshel, M. Anshel Goldfeld scheme as well. (Received June 27, 2011)

1072-20-216 **Allen Hatcher** and **Dan Margalit*** (margalit@math.gatech.edu). *Torelli groups and symplectic groups.*

The mapping class group $\mathrm{Mod}(S_g)$ of a closed orientable surface S_g is the group of orientation-preserving homeomorphisms of S_g, considered up to isotopy. The action of $\mathrm{Mod}(S_g)$ on $H_1(S_g;\mathbb{Z})$ gives rise to a surjective representation $\mathrm{Mod}(S_g) \to \mathrm{Sp}(2g,\mathbb{Z})$. In joint work with Allen Hatcher, we give a new proof of a theorem of Birman and Powell that gives a generating set for the kernel of this representation. We will also discuss applications to subgroups of $\mathrm{Mod}(S_g)$ and $\mathrm{Sp}(2g,\mathbb{Z})$. (Received June 28, 2011)

1072-20-235 **Mladen Bestvina**, **Alex Eskin** and **Kevin Wortman*** (wortman@math.utah.edu). *Filling coarse manifolds in arithmetic groups.*

A theorem of Lubotzky-Mozes-Raghunathan states that the word metric of any irreducible lattice L in a higher rank semisimple group G is quasi-isometric to the metric on L obtained by restricting the metric on G. In other words, given any two points x and y in L, there is a quasi-path in L that joins x to y and whose length is roughly the length of the shortest path between x and y in G.

In this talk I'll explain a conjectural generalization of Lubotzky-Mozes-Raghunathan from Bux-Wortman on the existence of metrically efficient "coarse" n+1 manifolds in L whose boundaries realize given n manifolds in L as long as the rank of G is at least n+2. I'll explain recent progress toward proving this conjecture, and how the conjecture implies some known finiteness properties of latices and some mostly unknown isoperimetric inequalities for lattices. This is joint work with Mladen Bestvina and Alex Eskin. (Received June 28, 2011)

1072-20-239 **Hanna Bennett***, hbennett@umich.edu. *Volume distortion in groups.*

Given a space X with subspace Y, a $(k-1)$-cycle in Y can be filled in two ways: either by restricting to k-chains in Y, or by allowing chains in all of X. The *k-volume distortion function* for Y in X gives a measure of the difference between the minimal volumes of such fillings. When groups G and H act on X and Y geometrically as a pair, we can use this to define the k-volume distortion of H in G. We will define these functions and compute some examples. (Received June 28, 2011)

22 ► Topological groups, Lie groups

1072-22-6 **Moshe Adrian*** (madrian@math.utah.edu), 164 J Street #1, Salt Lake City, UT 84103. *The local Langlands correspondence: from real to p-adic groups.*

The local Langlands correspondence for real groups has been known for quite some time. Over p-adic fields, the correspondence is by and large unknown, but there has been a fair amount of recent progress. I will present a new construction due to Dick Gross that mirrors the local Langlands theory over the reals, and I will give some examples of his construction. If there is time, I will show how to use Gross's theory to give a new realization of the depth zero local Langlands correspondence for PGSp(4,F) (where F is a p-adic field), which is joint work with Joshua Lansky. (Received June 09, 2011)

1072-22-43 **Paul Mezo*** (mezo@math.carleton.ca). *Character identities in twisted endoscopy.*

The Local Langlands Correspondence motivates the definition of endoscopic groups attached to a reductive algebraic group. The representations of these endoscopic groups are conjecturally related to the representations of the initial reductive group through character identities. Such character identities have been proven in the case of real reductive groups. We outline the proof of twisted character identities, when an automorphism of the real reductive group is introduced into the theory. (Received June 10, 2011)

1072-22-53 **Fiona Murnaghan*** (fiona@math.toronto.edu), Department of Mathematics, 40 Saint George Street, Toronto, Ontario M5S 2E4, Canada. *Relatively supercuspidal representations.*

Let H be the subgroup of points in a connected reductive p-adic group G that are fixed by a particluar involution of G. The notion of H-relatively supercuspidal representation of G was defined by Kato and Takano. Every irreducible smooth H-distinguished representation of G is a subrepresentation of a representation obtained by parabolic induction from an H-relatively supercuspidal representation of G. An H-distinguished representation of G is H-relatively supercuspidal if all of the relative matrix coefficients of the representation are compactly supported modulo HZ, where Z is the centre of G. We will describe a construction of H-relatively supercuspidal representations. (Received June 13, 2011)

1072-22-56 **Zhengyu Mao*** (zmao@rutgers.edu). *Some function equations for Whittaker functions on $GL(n)$.*

Theory of Rankin-Selberg integrals gives well known function equations for Whittaker functions on $GL(n)$. We discuss some other function equations that result from uniqueness of linear forms. (Received June 14, 2011)

1072-22-95 **Avraham Aizenbud*** (aizenr@gmail.com). *Cohen-Macaulay property in representation theory.*

This is a report about work in progress, joined with Eitan Sayag.

I will introduce several phenomena that occurs throughout representation theory of local and global groups. I'll mainly concentrate on the case of p-adic groups. These phenomena includes regular behavior of multiplicity of a representation when one varies the parameter of the representation, density of regular orbital integrals, and freeness of modules over Heke algebras. Often, when one tries to make these phenomena to a statement, one sees that either this statement is too weak or it is wrong. We believe that all these phenomena could be explained by the Cohen-Macaulay property of the regular representation attached to an homogenous space. We believe that this property is true in wide generality (for example the generality of spherical spaces) and we have proved them in some special cases. We have also shown that this property explains some of those phenomena. (Received June 22, 2011)

1072-22-113 **Thomas J. Baird*** (tbaird@mun.ca). *GKM-Sheaves and Equivariant Cohomology.*

Let T be a compact torus. Goresky, Kottwitz and Macpherson showed that for a large and interesting class of T-spaces X, the equivariant cohomology ring $H^*_T(X)$ can be encoded in a graph, now called a GKM-graph, with vertices corresponding to the fixed points of X and edges labeled by characters of T.

In this lecture, we explain how the GKM construction can be generalized to any finite T-CW complex. This generalization gives rise to new mathematical objects: GKM-hypergraphs and GKM-sheaves. If time permits, we will show how these methods were used to resolve a conjecture concerning the moduli space of flat connections over a non-orientable surface. (Received June 23, 2011)

1072-22-135 **Jeffrey Adams*** (jda@math.umd.edu), Mathematics Department, University of Maryland, College Park, MD 20742. *Birational Induction of Nilpotent Orbits.* Preliminary report.

Every nilpotent orbit of a complex reductive group may be uniquely realized as "saturated" from a "distinguished" orbit on a Levi factor (this is the Bala-Carter classification).

Alternatively, every orbit may be realized as induced from a rigid orbit on a Levi factor. However this realization is not unique. This can be improved: every orbit may be uniquely realized as "birationally induced" from a "birationally rigid" orbit. With this change there is a nice duality relationship with the Bala-Carter classification.

One of the difficulties in understanding the unitary dual is the fact that, similar to the situation for orbits, a representation may be induced in multiple ways. It turns out that, using the representation/orbit principle, restricting to birational induction of orbits plays a role in understanding the unitary dual. In joint work with Dan Barbasch I use this to organize the spherical unitary dual. (Received June 25, 2011)

1072-22-136 **Siddhartha Sahi*** (sahi@math.rutgers.edu), Department of Mathematics Rutgers University, Hill Center - Busch Campus, 110 Frelinghuysen Road, Piscataway, NJ 08854-8019, and **Dmitry Gourevitch** (dimagur@weizmann.ac.il), Faculty of Mathematics and Computer Science, The Weizmann Institute of Science, POB 26, 76100 Rehovot, Israel. *Associated varieties, derivatives, Whittaker functionals, and rank for unitary representations of GL(n,R).*

To each irreducible unitary representation π of $GL(n,\mathbb{R})$ one may associate a partition λ of n, which can be computed explicitly from the Vogan classification, and more generally from the annihilator variety of π.

Our first result shows λ determines (and is determined by) the existence of certain degenerate Whittaker functionals, for both smooth and K-finite vectors. This generalizes results of Casselman-Zuckerman, Kostant, Matumoto and others.

The second result relates λ to the sequence of Bernstein-Zelevinsky type highest derivatives, as defined in this setting by the speaker. This enables us to compute these highest derivative for almost all basic unitary representations of $GL(n,\mathbb{R})$, providing a partial answer to a question raised by the speaker in joint work with Stein.

The third result relates λ to Howe's notion of rank, as extended to $GL(n,\mathbb{R})$ by Scaramuzzi. This allows us to define a more refined notion of rank and answer an old question of Howe. (Received June 25, 2011)

1072-22-138 **Monica Nevins*** (mnevins@uottawa.ca), Department of Mathematics and Statistics, University of Ottawa, Ottawa, ON , Canada. *On Branching Rules for Supercuspidal Representations of reductive p-adic groups.* Preliminary report.

The branching rules under consideration are those arising from the restriction of an irreducible representation of a reductive p-adic group G to a maximal compact subgroup K. We report on recent progress towards understanding these branching rules for certain classes of supercuspidal representations and groups, using the parametrization of supercuspidal representations given by Yu. (Received June 25, 2011)

1072-22-139 **Yiannis Sakellaridis*** (sakellar@rutgers.edu), 101 Warren Street, Smith Hall 216, Newark, NJ 07102. *Unramified functions on a p-adic spherical variety.*

The Hecke module of unramified functions on a p-adic spherical variety has a very interesting combinatorial structure, which can be expressed in terms of a local L-function (depending on the variety). I will describe this structure, and some applications to automorphic forms and number theory. (Received June 25, 2011)

1072-22-148 **Roger Howe***, Department of Mathematics, Yale University, PO BOX 208283, New Haven, CT 06520. *Branching Rules and Hibi Rings.*

We will review the role of algebraic methods, and especially the appearance of Hibi rings, in describing finite dimensional representations of classical Lie groups, including branching rules and related issues. (Received June 26, 2011)

1072-22-158 **Wai Ling Yee*** (wlyee@uwindsor.ca), Department of Mathematics and Statistics, Lambton Tower, 10th Floor, 401 Sunset Avenue, Windsor, Ontario N9J 3L6, Canada. *Unifying Bruhat Order for BGB, PGB, KGB, and KGP.*

The usual Bruhat order, parabolic Bruhat order, and Bruhat order for symmetric pairs are shown to have combinatorially analogous and relatively simple descriptions. (Received June 27, 2011)

1072-22-162 **Hadi Salmasian*** (hsalmasi@uottawa.ca). *Harmonic analysis on finite and infinite dimensional Lie supergroups.*

We will present recent results on unitary representations of Lie supergroups. We show that the categories of smooth and analytic unitary representations of Banach-Lie supergroups are well-behaved under a natural restriction functor. This generalizes the existing results for finite dimensional Lie groups. We will also explain how the orbit method and the GNS construction can be adapted to the super context. Time permitting, We will outline the application of our results to generalize the Kirillov-Olshanski theory of unitary representations of infinite dimensional classical supergroups. Part of this talk is based on joint works with Karl-Hermann Neeb and Stephane Merigon. (Received June 27, 2011)

1072-22-169 **Peter Speh*** (pspeh@mit.edu), Room 2-093, Department of Mathematics, MIT, 77 Massachusetts Avenue, Cambridge, MA 02139. *Representation Theory research.*

I will speak about my research in representation theory. (Received June 27, 2011)

28 ► Measure and integration

1072-28-159 **Masanori Hino***, Kyoto University, Kyoto, 606-8501, Japan. *Differential-like structures associated with strong local Dirichlet forms.*

On a certain class of self-similar fractals, it has been observed already by S. Kusuoka and J. Kigami around 1990 that differential-like structures are associated with self-similar Dirichlet forms. In this report, I will discuss similar structures with respect to strong local Dirichlet forms on general state spaces and the first-order Taylor expansion of functions in the domain of the Dirichlet form. (Received June 27, 2011)

1072-28-177 **Alex Iosevich*** (iosevich@math.rochester.edu). *Regular value theorem in a fractal setting.*

The classical regular value theorem says that if X, Y are smooth manifolds of dimensions n and m, $n > m$, respectively, and $F : X \to Y$ is a submersion on the set $\phi^{-1}(y) = \{x \in X : F(x) = y\}$, then $\phi^{-1}(y)$ is either empty or is a smooth $n - m$ sub-manifold of X. In this talk we shall see that under appropriate assumption on F, X may be taken to be an arbitrary product type set of a given Hausdorff dimension. Sobolev bounds for generalized radon transforms play a key role and the sharpness examples are based on the theory of distribution of lattice points on polynomial surfaces (Received June 27, 2011)

1072-28-240 **Daniel J Kelleher*** (kelleher@math.uconn.edu), **Matthew Begue**, **Aaron Nelson**, **Hugo Panzo**, **Ryan Pellico** and **Alexander Teplyaev**. *Random walks on barycentric subdivisions and the Strichartz hexacarpet.*

We investigate the relation between simple random walks on repeated barycentric subdivisions of a triangle and a self-similar fractal, Strichartz hexacarpet, which we introduce. We explore a graph approximation to the hexacarpet in order to establish a graph isomorphism between the hexacarpet approximations and Barycentric subdivisions of the triangle, and discuss various numerical calculations performed on the these graphs. We prove that equilateral barycentric subdivisions converge to a self-similar geodesic metric space of dimension log(6)/log(2), or about 2.58. Our numerical experiments give evidence to a conjecture that the simple random walks on the equilateral barycentric subdivisions converge to a continuous diffusion process on the Strichartz hexacarpet corresponding to a different spectral dimension (estimated numerically to be about 1.74). (Received June 29, 2011)

1072-28-243 **Nishu Lal*** (nishul@math.ucr.edu), Department of Mathematics, University of California, Riverside, 261 Surge Building, Riverside, CA 92521, and **Michel Lapidus** (lapidus@math.ucr.edu), Department of Mathematics, University of California, Riverside, 231 Surge Building, Riverside, CA 92521. *Higher-dimensional complex dynamics and spectral zeta functions of fractal Sturm-Liouville operators.*

We will discuss the spectral zeta function of a self-similar Sturm-Liouville operator on the half real line and C. Sabot's work on connecting the spectrum of this operator with the iteration of a rational map of several complex variables. The Sturm-Liouville operator on $[0, \infty)$ is viewed as a limit of the sequence of operators $\frac{d}{dm_{<n>}}\frac{d}{dx}$ with Dirichlet boundary condition on $I_{<n>} = [0, \alpha^{-n}]$ which are the infinitesimal generators of the Dirichlet form $(a_{<n>}, m_{<n>})$. In particular, it is defined in terms of a self-similar measure m and Dirichlet form a, relative to a suitable iterated function system on $I = [0, 1]$. In the case of the Sierpinski gasket, as was shown by A. Teplyaev, extending the known relation by M. Lapidus for fractal strings, the spectral zeta function of the Laplacian has a product structure with respect to the iteration of a rational map on $\mathbb{C}$ which arises from

the decimation method. In the case of the above self-similar Sturm-Liouville problem, we obtain an analogous product formula, but now expressed in terms of the (suitably defined) zeta function associated with the dynamics of the corresponding 'renormalization map', viewed as a rational function on $\mathbb{P}^2(\mathbb{C})$. (Received June 29, 2011)

1072-28-247 **Vadim Kaimanovich*** (vkaimano@uottawa.ca), Department of Mathematics and Statistics, Uiversity of Ottawa, 585 King Edward, Ottawa, ON K1N 6N5, Canada. *Hyperbolicity of graphs associated with fractal sets.* Preliminary report.

We shall present criteria which guarantee that various graphs associated with fractal sets are Gromov hyperbolic. In this situation the fractal set itself can be realized as the hyperbolic boundary of the associated graph. We shall discuss applications of this presentation. (Received June 29, 2011)

1072-28-253 **Marianna Csornyei*** (mari@math.ucl.ac.uk). *Tangents of null sets and of sets of positive measure.*

We will discuss product decompositions of measures and show how product formulas can detect directionality in null sets and in sets of positive measure. The talk is based on a joint work with G. Alberti, P. Jones and D. Preiss. (Received June 29, 2011)

1072-28-272 **Marius V Ionescu**, **Luke G Rogers*** (luke.rogers@uconn.edu) and **Alexander Teplyaev**. *Piecewise harmonic functions, derivations and 1-forms on certain fractals.*

We consider how the abstract results of Cipriani and Sauvageot about derivations associated to Dirichlet forms on pcf self-similar fractals may be computed in the case of resistance forms using piecewise harmonic functions, and the consequences for 1-forms, Hodge theory and a type of phase operator. (Received June 29, 2011)

30 ► Functions of a complex variable

1072-30-8 **Andy Raich*** (araich@uark.edu), Department of Mathematical Sciences, SCEN 327, 1 University of Arkansas, Fayetteville, AR 72701, and **Luca Capogna**. *An Aronsson Type Approach to Extremal Quasiconformal Mappings.*

I will discuss C^2 extremal quasiconformal mappings in space. I will establish necessary and sufficient conditions for a 'localized' form of extremality to hold. This will be in the spirit of the work of G. Aronsson on absolutely minimizing Lipschitz extensions. Time permitting, we also discuss the short time existence for smooth solutions of a gradient flow of QC diffeomorphisms associated to the extremal problem. This project is joint with Luca Capogna of the University of Arkansas. (Received April 15, 2011)

1072-30-117 **Andrew Lorent*** (lorentaw@uc.edu), 2600 Clifton Ave., Cincinnati, OH 45221. *Multiwell Liouville Theorems and pairs of functions whose symmetric part of gradient are close.*

A corollary to Liouville's theorem is that if a Sobolev mapping u satisfies $Du \in SO(n)$ a.e. then u is affine. Following the optimal quantitative generalization of this corollary by Friesecke, James, Müller there have been many developments establishing quantitative analogues of well known theorems in elasticity and quasiconformal analysis. We survey these developments focusing on generalizations of F-J-M theorem to multi-wells and to rigidity of pairs of functions whose symmetric part of gradient are close. (Received June 23, 2011)

1072-30-185 **James T Gill*** (gill@math.washington.edu) and **Steffen Rohde**. *On the Riemann surface type of Random Planar Maps.*

We show that the (random) Riemann surfaces of the Angel-Schramm Uniform Infinit Planar Triangulation and of Sheffield's infinie necklace construction are both parabolic. In other words, Brownian motion on these surfaces is recurrent. We obtain this result as a corollary to a more general theorem on subsequential distributional limits of random unbiased disc triangulations, following work of Benjamini and Schramm. (Received June 27, 2011)

1072-30-273 **Brett D. Wick*** (wick@math.gatech.edu), School of Mathematics, Georgia Institute of Technology, 686 Cherry Street, Atlanta, GA 30332-1060. *Results in Complex Analysis and Operator Theory.*

We report on some recent results with collaborators. (Received June 30, 2011)

31 ► Potential theory

1072-31-19 **Matthew Badger*** (mbadger@math.washington.edu), University of Washington, Department of Mathematics, Box 354350, Seattle, WA 98195-4350. *Lipschitz Approximation to Corkscrew Domains and Harmonic Measure.*

We show Guy David and David Jerison's construction of Lipschitz graphs inside a corkscrew domain does not require surface measure be upper Ahlfors regular. As an application we obtain a partial F. and M. Riesz theorem for harmonic measure on NTA domains of locally finite perimeter. (Received May 16, 2011)

1072-31-163 **Ka-Sing Lau** (kslau@math.cuhk.edu.hk), Department of Mathematics, The Chinese University of Hong Kong, Shatin, N.T., Hong Kong, and **Sze-Man Ngai*** (smngai@georgiasouthern.edu), Department of Mathematical Sciences, Georgia Southern University, Statesboro, GA 30460-8093. *Martin boundary and exit space on the Sierpinski gasket and other fractals.*

We define a Markov chain on a discrete symbolic space corresponding to the Sierpinski gasket (SG) and show that its Martin boundary is homeomorphic to the SG, while the minimal Martin boundary can be identified with the three vertices of the SG. Moreover, we show that the harmonic functions coincide with the standard ones. We also consider generalizations to a larger class of p.c.f. fractals. This is a joint work with Ka-Sing Lau. (Received June 27, 2011)

33 ► Special functions

1072-33-12 **Daniel Joseph Galiffa*** (djg34@psu.edu). *On the Classical and Quantum Orthogonal Polynomial Solutions to a Class of Differential-Difference Equations.*

We first briefly address how orthogonal polynomial solutions have previously been extracted from the differential-difference equation $\pi(x)DP_n(x) = (\alpha_n x + \beta_n)P_n(x) + \gamma_n P_{n-1}(x)$, where $\pi(x)$ is a polynomial of degree at most 2, with respect to both the differential operator $D = d/dx$ and the quantized difference operator $D = D_q$. From there, we discuss how orthogonal polynomial solutions were recently obtained from this equation with respect to the operator $D = D_{q^{-1}}$. Among these solutions were the well-known and fully classified Al-Salam Carlitz II, discrete q-Hermite II, q-Laguerre and Stieltjes-Wigert polynomials. In addition, we also elaborate on the orthogonal polynomial solutions which were obtained that, to the best of our knowledge, have not been fully characterized and require further analysis. We conclude with a discussion regarding the future research that stems from this work and a generalization to the equation above. This research was completed in conjunction with Sarah J. Johnston; University of the Witwatersrand, S. Africa. (Received May 05, 2011)

35 ► Partial differential equations

1072-35-18 **Huanjun Gong**, School of Mathematics, Fudan University, Shanghai, 200433, Peoples Rep of China, **Tobias Lamm**, Institut fur Mathematik, Goethe-Universitat Frankfurt, 1060054 Frankfurt, Germany, and **Changyou Wang***, Department of Mathematics, University of Kentucky, Lexington, KY 40506. *Boundary regularity of stationary biharmonic maps.* Preliminary report.

In this talk, I will introduce a class of globally stationary biharmonic maps from a bounded domain into a Riemannian manifold. We show that such a class of biharmonic maps are smooth up to the boundary away from a closed subset of zero $n-4$-dimensional Hausdorff measure. This is a joint work with Huajun Gong and Tobias Lamm. (Received May 16, 2011)

1072-35-23 **Thomas H. Otway***, 500 W 185th Street, New York, NY 10033. *Wave propagation in the cold plasma model.*

An elliptic-hyperbolic equation which models wave propagation through zero-temperature plasma is analyzed. Boundary-value problems formulated on the basis of conventional electromagnetic theory turn out to be classically ill-posed in this context. Nevertheless, conditions may be prescribed under which a solution to the Dirichlet problem exists in an appropriate sense. Conditions are given for distribution, weak, and strong solutions. (Received May 20, 2011)

1072-35-25 **Anthony Suen*** (cksuen@indiana.edu), Indiana University, Bloomington, IN 47405, and **David Hoff**. *Global Low-Energy Weak Solutions of the Equations of 3D Compressible Magnetohydrodynamics.*

We prove the global-in-time existence of weak solutions of the equations of compressible magnetohydrodynamics in three space dimensions with initial data small in L^2 and initial density positive and essentially bounded. A great deal of information concerning partial regularity is obtained: velocity, vorticity, and magnetic field become relative smooth in positive time (H^1 but not H^2) and singularities in the pressure cancel those in a certain multiple of the divergence of the velocity, thus giving concrete expression to conclusions obtained formally from the Rankine-Hugoniot conditions. (Received May 22, 2011)

1072-35-27 **Matthias L Youngs*** (youngsml@indiana.edu) and **David Hoff**. *Existence of weak solutions to a model for sparse, one-dimensional, non-barotropic fluids.*

We prove the global existence of weak solutions to a model for a one-dimensional, viscous, compressible, non-barotropic fluid initially occupying a general open subset of a finite measure. The fluid equations are applied only on the support of the density, understood in the sense of distributions. This support must be tracked in time and accommodation must be made for the possibly infinite number of collisions of fluid packets occurring on a possibly dense set of collision times. Our approach avoids certain nonphysical properties of solutions which are constructed as limits of solutions in which artificial mass has been inserted and, instead, gives a solution that is locally momentum conserving. Our tactic is to build and prove a reasonable theory for finitely many fluid packets and then use weak compactness to let the number of fluids go to infinity. (Received May 23, 2011)

1072-35-31 **Antonella Marini*** (anto_marini@libero.it) and **Thomas H. Otway**. *On the Hodge-Frobenius equations.*

A system of elliptic-hyperbolic equations for differential forms is discussed. This system reduces in various special cases to equations for compressible flow with rotation, the Born-Infeld equations, equations for rigid-body rotation, and equations for pseudo-plastic flow. Little is known about these equations except in the (degenerately) elliptic special case. A few results are independent of type and suggest conjectures for the elliptic-hyperbolic case. (Received May 24, 2011)

1072-35-45 **Kasso Okoudjou*** (kasso@math.umd.edu), University of Maryland, College Park, MD 20742, and **Luke Rogers** and **Robert Strichartz**. *Szego limit theorems on the Sierpinski gasket.*

In this talk, I will show how the existence of localized eigenfunctions of the Laplacian on the Sierpiński gasket can be used to formulate and prove analogues of the strong Szegö limit theorem in this fractal setting. (Received June 10, 2011)

1072-35-64 **Bing Wang*** (bingw@math.princeton.edu). *on the gap phenomena of singularities of the Ricci flow.*

We develop some estimates under the Ricci flow and use these estimates to study the blowup rates of curvatures at singularities. As applications, we obtain some gap theorems: $\sup_X |Ric|$ and $\sqrt{\sup_X |Rm|}\cdot\sqrt{\sup_X |R|}$ must blowup at least at the rate of type-I. Our estimates also imply some gap theorems for shrinking Ricci solitons. (Received June 15, 2011)

1072-35-75 **Daniela Lupo**, **Dario D. Monticelli** and **Kevin R. Payne*** (kevin.payne@unimi.it), Dipartimento di Matematica, Universita' di Milano, Via Saldini, 50, 20133 Milano, Italy. *Spectral Theory for Linear Operators of Mixed Type and Applications to Nonlinear Dirichlet Problems.*

For a class of linear partial differential operators L of mixed elliptic-hyperbolic type in divergence form with homogeneous Dirichlet data on the entire boundary of suitable planar domains, we exploit the recent weak well-posedness result of Lupo-Morawetz-Payne [Comm. Pure Appl. Math. 2007] and minimax methods to establish a complete spectral theory in the context of weighted Lebesgue and Sobolev spaces. In particular, we find a basis for a weighted version of the space $H_0^1(\Omega)$ comprised of weak eigenfunctions which are orthogonal with respect to a natural bilinear form associated to L. The associated eigenvalues $\{\lambda_k\}_{k\in\mathbb{N}}$ are all non zero, have finite multiplicity and yield a doubly infinite sequence tending to $\pm\infty$. The solvability and spectral theory are then combined with topological methods of nonlinear analysis to establish the first results on existence, existence with uniqueness and bifurcation from $(\lambda_k, 0)$ for associated semilinear Dirichlet problems. The work to be presented is in collaboration with Daniela Lupo (Politecinco di Milano) and Dario Monticelli (Università di Milano). (Received June 19, 2011)

1072-35-77 **Gregory Berkolaiko** and **Peter Kuchment***, kuchment@math.tamu.edu, and **Uzy Smilansky**. *Nodal counts of billiard eigenfunctions and critical partitions.*

In this talk we address the nodal count (i.e., the number of nodal domains) for eigenfunctions of Schroedinger operators with Dirichlet boundary conditions in bounded domains (billiards). The classical Sturm theorem claims that in dimension one, the nodal and eigenfunction counts coincide: the n-th eigenfunction has exactly n nodal domains. The Courant Nodal Theorem claims that in any dimension, the number of nodal domains of the n-th eigenfunction cannot exceed n. However, it follows from a stronger upper bound by Pleijel that in dimensions higher than 1 the equality can hold for only finitely many eigenfunctions. Thus, in most cases a "nodal deficiency" arises. Moreover, examples are known of eigenfunctions with an arbitrarily large index n that have just two nodal domains.

We show that, under some genericity conditions, the answer can be given in terms of a functional on an infinite dimensional variety of partitions of the billiard, whose critical points correspond exactly to the nodal partitions and Morse indices coincide with the nodal deficiencies. (Received June 19, 2011)

1072-35-83 **Eun Heui Kim*** (ekim4@csulb.edu), 1250 Bellflower Blvd, Department of Mathematics, California State University Long Beach, Long Beach, CA 90840. *Global solutions for transonic self-similar two-dimensional Riemann problems.*

In this talk, we present the existence results of global self-similar solutions for transonic two-dimensional Riemann problems. (Received June 20, 2011)

1072-35-105 **Marcus A. Khuri*** (khuri@math.sunysb.edu). *Boundary Value Problems for Mixed Type Equations and Applications.*

In this talk we outline a general method for finding well-posed boundary value problems for linear equations of mixed elliptic and hyperbolic type, which extends previous techniques of Berezanskii, Didenko, and Friedrichs. This method is then used to study a particular class of fully nonlinear mixed type equations which arise in applications to differential geometry. (Received June 23, 2011)

1072-35-109 **Thomas Bieske*** (tbieske@usf.edu), 4202 E. Fowler Ave, PHY 114, Tampa, FL 33620. *The Carnot-Caratheodory distance and the p-Laplace equation.*

We explore the relationship between geodesics in the Carnot-Caratheodory metric and viscosity solutions to the p-Laplace equation. (Received June 23, 2011)

1072-35-137 **Dehua Wang*** (dwang@math.pitt.edu). *Some mixed type problems in gas dynamics and geometry.*

Some mixed type PDE problems arising in the transonic flow past an obstacle in gas dynamics and the isometric embedding in geometry will be discussed. (Received June 25, 2011)

1072-35-165 **Nedyu I. Popivanov*** (nedyu@fmi.uni-sofia.bg). *Supercritical and critical cases for 2D and 3D BV problems for quazilinear equations of mixed elliptic-hyperbolic type.*

We prove the nonexistence of nontrivial solutions for some linear classical planar problems studied by Tricomi, Frankl' and Guderlay-Morawetz, with additional nonlinearity having supercritical or critical growth. In the 3D case we study some Morawetz-Protters problems, which are strongly ill-posed even in the case of the wave equation or for weakly hyperbolic case. The results follow from integral identities of Pohožaev type, suitably calibrated to achieve an invariance with respect to anisotropic dilations in the linear part of the equation. In the case of critical growth, the nonexistence principle is established by combining the dilation identity with another energy identity. For boundary value problems in which the boundary condition is imposed on a proper subset of the boundary (i.e. not on the whole boundary), sharp Hardy-Sobolev inequalities are used to control terms in the integral identity corresponding to the lack of a boundary condition. These problems will be discussed not only for the classical solutions, but also in the frame of generalized solution. (Received June 27, 2011)

1072-35-171 **xianpeng Hu*** (xianpeng@cims.nyu.edu). *The vanishing viscosity limit of the incompressible magnetohydrodynamics with zero magnetic diffusivity.* Preliminary report.

In this talk, we consider the existence of weak solutions to the 3-dimensional incompressible magnetohydrodynamics with zero magnetic diffusivity. The existence will be verified via a vanishing viscosity limit of the viscous incompressible magnetohydrodynamics. (Received June 27, 2011)

1072-35-204 **Deane Yang*** (dyang@poly.edu), Six Metrotech Center, Brooklyn, NY 11201. *Questions in centro-affine geometry.* Preliminary report.

We show how questions in the centro-affine geometry of convex bodies can be generalized to non-convex hypersurfaces, leading to interesting non-elliptic Monge-Ampère equations. (Received June 28, 2011)

1072-35-209 **Dan Knopf*** (danknopf@math.utexas.edu), **Zhou Gang** and **I M Sigal**. *Neckpinch dynamics for asymmetric surfaces evolving by mean curvature flow.*

We study surfaces evolving by mean curvature flow (MCF). For an open set of initial data that are C^3-close to round, but without assuming rotational symmetry, we show that MCF solutions become singular in finite time by forming neckpinches, and we obtain detailed asymptotics of that singularity formation. In particular, we show that MCF solutions become asymptotically rotationally symmetric near the neckpinch singularity. (Received June 28, 2011)

1072-35-219 **Natasa Sesum*** (natasas@math.rutgers.edu), 110 Frelinghuysen road, Piscataway, NJ, and **Panagiota Daskalopolous** and **Manuel Delpino**. *Ancient solutions in geometric flows.* Preliminary report.

In this joint work with Daskalopolous and Del Pino we will describe the method of constructing the ancient solutions to the Yamabe flow. This shows that the parabolic version of classifying the ancient solutions to the Yamabe flow is much more difficult than the classification of the entire solutions to the corresponding elliptic stationary problem. (Received June 28, 2011)

1072-35-244 **Pengfei Guan** and **Junfang Li*** (jfli@uab.edu). *A mean curvature type of flow and isoperimetric inequality.* 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 $t \in [0, \infty)$ and exponentially converges to a round sphere. Moreover, we will show that all the quermassintegrals evolve monotonically along this flow. As a consequence we prove a class of Alexandrov-Fenchel inequalities including the classical isoperimetric inequality. (Received June 29, 2011)

1072-35-249 **Barbara Lee Keyfitz*** (bkeyfitz@math.ohio-state.edu), Department of Mathematics, 231 West 18th Avenue, The Ohio State University, Columbus, OH 43210. *Singularities at the Sonic Line.* Preliminary report.

In hyperbolic systems that portray acoustic phenomena – the prototype is compressible fluid flow – the difference between 'subsonic' and 'supersonic' states can be described via some subtle properties of the wave cone. But when one restricts to self-similar solutions (steady or uniformly expanding in time) the difference manifests itself as change of type in the equations, from hyperbolic (supersonic) to elliptic or mixed type (subsonic). Recently, in joint work with Allen Tesdall, we have made some progress in identifying different ways in which singularities (that is, shock waves) can be formed at the sonic line in self-similar equations. (Received June 29, 2011)

1072-35-269 **Allen M. Tesdall*** (allen.tesdall@csi.cuny.edu) and **John K. Hunter** (hunter@math.ucdavis.edu). *Self-similar solutions for the diffraction of weak shocks.*

We formulate a problem for the unsteady transonic small disturbance equations that describes the diffraction of a weak shock near a point where its strength approaches zero and the shock turns into an expansion wave. Physically, this problem corresponds to the reflection of a weak shock wave by a semi-infinite screen at normal incidence. We formulate the equations in special self-similar variables, and obtain numerical solutions using high resolution schemes. Our solutions appear to show that the shock dies out at the sonic line, a phenomenon which has not been previously observed. (Received June 29, 2011)

1072-35-275 **Katarina Jegdic*** (jegdick@uhd.edu). *A Riemann problem for the two-dimensional isentropic gas dynamics equations.*

We consider a two-dimensional Riemann problem for the isentropic gas dynamics equations leading to strong regular reflection. We rewrite the problem using the self-similar coordinates and we obtain a mixed type system and a free boundary problem for the subsonic state and the reflected shock. Using the theory of second order elliptic equations and various fixed point arguments, we prove local existence of a solution. (Received June 30, 2011)

37 ► Dynamical systems and ergodic theory

1072-37-48 **Rocio E. Ruelas**, **Richard H. Rand*** (rrand@cornell.edu) and **David G. Rand**. *Nonlinear Evolutionary Dynamics of a Rock-Paper-Scissors System with Periodic Coefficients.* Preliminary report.

We investigate a problem in evolutionary game theory based on replicator equations with periodic coefficients. This approach to evolution combines classical game theory with differential equations. The Rock-Paper-Scissors system studied has application to the population biology of lizards and to bacterial dynamics. The presence of periodic coefficients models variations in the environment due to seasonal effects.

This work extends previous work (Communications in Nonlinear Science and Numerical Simulation 16:3887-3895, 2011) by considering the effect of nonlinear terms. A Poincare map P is obtained by taking cuts at times t=nT, n=0,1,2,..., where T is the period of the periodic coefficients. Periodic points in P correspond to subharmonic periodic motions in the original system. The properties of the map P are explored by using perturbation methods and numerical integration. (Received June 13, 2011)

1072-37-50 **Erik M Bollt*** (bolltem@clarkson.edu), Clarkson University, Department of Mathematics, Potsdam, NY 13676. *SYNCHRONIZATION AS A PROCESS OF SHARING AND TRANSFERRING INFORMATION.*

Synchronization of chaotic oscillators has become well characterized by errors which shrink relative to a synchronization manifold. This manifold is the identity function in the case of identical systems, or some other slow manifold in the case of generalized synchronizaton in the case of nonidentical components. On the other hand, since many decades beginning with the Smale horseshoe, chaotic oscillators can be well understood in terms of symbolic dynamics as information producing processes. We study here the synchronization of a pair of chaotic oscillators as a process of their sharing information bearing bits transferred between each other, by measuring the transfer entropy tracked as the global systems transitions to the synchronization state. Further, we present for the first time the notion of transfer entropy in the measure theoretic setting of transfer operators. (Received June 13, 2011)

1072-37-92 **Tamas Wiandt*** (tiwsma@rit.edu), 85 Lomb Memorial Dr, Rochester, NY 14623. *Decomposition possibilities for closed relations.*

We present a short overview of the theory of dynamics of closed relations on compact Hausdorff spaces. We establish generalizations for some topological aspects of dynamical systems theory, including recurrence and attractor-repeller structure, and we investigate possible extensions for Morse and Conley decompositions. (Received June 21, 2011)

1072-37-97 **Jiongxuan Zheng*** (jizheng@clarkson.edu), Jiongxuan Zheng, 105 Swan St., Potsdam, NY 13699, and **Erik Bollt** and **Joe Skufca**. *Heart Rate Variability as Determinism with Jump Stochastic Parameters.*

We use measured heart rate information (RR intervals) to develop a one-dimensional nonlinear map that describes short term behavior. Our study suggests that there is a stochastic parameter with persistence which causes the heart rate and rhythm system to wandering about a bifurcation point. We propose a modified circle map with a time-correlated noise term as a model which can capture such stochastic behaviors of the system. (Received June 22, 2011)

1072-37-121 **Sean Kramer*** (kramersj@clarkson.edu), Box: 5815, 8 Clarkson Ave, Potsdam, NY 13699, **Erik Bollt** (bolltem@clarkson.edu), Box: 5815, 8 Clarkson Ave, potsdam, NY 13699, **Aaron Luttman** (aluttman@clarkson.edu), Box: 5815, 8 Clarkson Ave, Potsdam, NY 13699, **Ranil Basnayake**, Box: 5815, 8 Clarkson Ave, Potsdam, 13699, and **Tian Ma**, Box: 5815, 8 Clarkson Ave, Potsdam, NY 13699. *Hydrobiological Modeling with Hyperspectral Satellite Imagery.*

Plankton blooms severely impact coastal regions. We model this ecology as informed by hyperspectral remote sensing instruments mounted on ocean-observing satellites. Flow fields are inferred from satellite imagery by inverse problem techniques. We analyze transport in resulting vector fields by Finite-Time Lyapunov Exponents, revealing pseudo-barriers in the flow. Global modeling methods for the population dynamic reaction diffusion advection systems will also be discussed. (Received June 24, 2011)

1072-37-250 **Volodymyr Nekrashevych*** (nekrash@math.tamu.edu), Department of Mathematics, Texas A&M University, College Station, TX 77843. *Hyperbolic duality and analysis on fractals.* Preliminary report.

We will talk about hyperbolic pseudogroups of local self-similarities of a topological space and their duals (which are also hyperbolic pseudogroups). Duality can be used to construct natural metric and measure classes on the space. We will discuss possible approaches to analysis on fractals in this setting. (Received June 29, 2011)

39 ► Difference and functional equations

1072-39-11 **Frank J. Palladino*** (frank@math.uri.edu). *On Periodic Trichotomies.*

We discuss several general periodic trichotomy results in the literature. We discuss some open questions regarding periodic trichotomies and several patterns of periodic trichotomy behavior. (Received May 03, 2011)

1072-39-16 **Harold M Hastings*** (harold.hastings@hofstra.edu), Department of Physics - Berliner 102, 151 Hofstra University, Hempstead, NY 11549-1510. *Limits on predictability in systems of stochastic difference equations.*

Many "complex" systems, included ecological and financial systems, can be modeled by systems of stochastic difference equations. This talk will explore limits on predictability in such systems, especially those arising from limited samples of their dynamical behavior. This material is based upon work supported by the Department of Energy under Award Number DE-FG02-08ER64623.This report was prepared as an account of work sponsored by an agency of the United States Government. Neither the United States Government nor any agency thereof, nor any of their employees, makes any warranty, express or implied, or assumes any legal liability or responsibility for the accuracy, completeness, or usefulness of any information, apparatus, product, or process disclosed, or represents that its use would not infringe privately owned rights. Reference herein to any specific commercial product, process, or service by trade name, trademark, manufacturer, or otherwise does not necessarily constitute or imply its endorsement, recommendation, or favoring by the United States Government or any agency thereof. The views and opinions of authors expressed herein do not necessarily state or reflect those of the United States Government or any agency thereof. (Received May 16, 2011)

1072-39-24 **Edward Grove** and **Evelina Giusti Lapierre*** (elapierre@jwu.edu), Mathematics Department, 8 Abbott Park Place, Providence, RI 02903, and **Wirot Tikjha**. *On the global behavior of the system of piecewise linear difference equations* $x_{n+1} = |x_n| + ay_n + b$ *and* $y_{n+1} = x_n + c|y_n| + d$. Preliminary report.

We give a detailed analysis, complete with open problems and conjectures, of the global character of the solutions of the piecewise linear difference equations

$$\begin{cases} x_{n+1} &= |x_n| + ay_n + b \\ \\ y_{n+1} &= x_n + c|y_n| + d \end{cases}, \quad n = 0, 1, \ldots$$

where the initial condition $(x_0, y_0) \in \mathbf{R}^2$ and the parameters $a, b, c, d \in \{-1, 0, 1\}$. (Received May 22, 2011)

1072-39-35 **Chris D. Lynd*** (Chris_Lynd@my.uri.edu). *Global solutions to systems of difference equations.* Preliminary report.

We will present the global character of solutions for several systems of difference equations in the plane. (Received May 30, 2011)

42 ► Fourier analysis

1072-42-73 **Michael T. Lacey**, School of Mathematics, Georgia Institute of Technology, Atlanta, GA 30332, **Eric T. Sawyer**, Department of Mathematics and 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. *On weighted inequalities for singular integrals.*

In this talk I will report on some joint work mainly with M. Lacey and E. Sawyer on weighted inequalities, as pertaining to the two weight problem for the Hilbert transform and related problems. If time permits, I would also make reference to further more recent work with M. Lacey, E. Saywer et al. on the same topic. (Received June 17, 2011)

46 ► Functional analysis

1072-46-29 **Marius V Ionescu*** (mionescu@colgate.edu), 13 Oak Dr, Hamilton, NY 13346, and **Luke G Rogers** and **Robert S Strichartz**. *Pseudo-differential operators on fractals.*

Abstract. We define and study pseudo-differential operators on a class of fractals that include the so called post-critically finite self-similar sets and Sierpinski carpets. Using the sub-Gaussian estimates of the heat operator we prove that our operators have kernels that decay and, in the constant coefficient case, are smooth off the diagonal. Our analysis can be extended to product of fractals. While our results are applicable to a larger class of metric measure spaces with Neumann Laplacian, we apply them to study elliptic, hypoelliptic, and quasi-elliptic operators on p.c.f. fractals, answering a few open questions posted in a series of recent papers. We extend our class of operators to include the so called Hörmander elliptic operators. We also initiate the study of wavefront sets and microlocal analysis on p.c.f. fractals. (Received May 24, 2011)

1072-46-221 **Fabio Cipriani** and **Daniele Guido*** (guido@mat.uniroma2.it), Dipartimento di Matematica, Univ. Roma Tor Vergata, via della Ricerca Scientifica, Roma, Italy, and **Tommaso Isola** and **Jean-Luc Sauvageot**. *Differential 1-forms, their Integrals and Potential Theory on the Sierpinski Gasket.*

We provide a definition of differential 1-forms on the Sierpinski gasket K and their integrals on paths. We show how these tools can be used to build up a Potential Theory on K. In particular, we prove: i) a de Rham reconstruction of a 1-form from its periods around lacunas in K; ii) a Hodge decomposition of 1-forms with respect to the Hilbertian energy norm; iii) the existence of potentials of elementary 1-forms on suitable covering spaces of K. We then apply this framework to the topology of the fractal K, showing that each element of the dual of the first Cech homology group is represented by a suitable harmonic 1-form [arXiv:1105.1995] (Received June 28, 2011)

1072-46-231 **Alexander A Katz*** (katza@stjohns.edu), St. John's University, SJC, Dep. of Mathematics and Computer Science, 300 Howard Ave., DaSilva AC 314, Staten Island, NY 10301. *Injective Envelopes of Fréchet Spaces.*

It was shown by Cohen in 1964 that in the category of Banach spaces and linear contraction mappings between them each Banach space has a unique injective envelope up to a linear isometry. Generalizing this work we introduce the notion of a locally contractive linear mapping and a locally isometric linear mapping between Fréchet Locally Convex Spaces. It is then shown that in the category of Fréchet Locally Convex Spaces and locally contractive linear mappings between them an jnjective envelope for each Fréchet Locally Convex Space always exists and it is unique up to a locally isometric linear mapping. (Received June 28, 2011)

1072-46-241 **Hafedh Herichi***, 900 University Ave, Riverside, CA 92521, and **Michel. L. Lapidus**, 900 University Ave, Riverside, CA 92521. *On a Reformulation of the Riemann hypothesis within the Theory of Complex Dimensions in Fractal Geometry.*

The spectral operator was introduced for the first time by M. L. Lapidus and his collaborator M. van Frankenhuijsen in their theory of complex dimensions in fractal geometry. The corresponding inverse spectral problem was first considered by M. L. Lapidus and H. Maier in their work on a spectral reformulation of the Riemann hypothesis in connection with the question "Can One Hear The Shape of a Fractal String?". The spectral operator is defined on a suitable Hilbert space as the operator mapping the counting function of a generalized fractal string η to the counting function of its associated spectral measure. It relates the spectrum of a fractal string with its geometry. During this talk, we will be discussing some fundamental properties of this operator and provide a condition ensuring its invertibility which is related to the Riemann hypothesis. (Received June 29, 2011)

1072-46-254 **Fabio E.G. Cipriani*** (fabio.cipriani@polimi.it), Piazza Leonardo da Vinci 32, 20133 Milano, Italy. *Spectral Triples on the Sierpinski gasket.*

The aim of the seminar is to reports on collaborations with D. Guido, T. Isola (Roma - University Tor Vergata)and J.L. Sauvageot (University Paris VII) show how to construct Dirac operators D and Spectral Triples $(\mathcal{F}, D, H)$, in the sense on A. Connes, on the Sierpinski gasket K, starting from the canonical Dirichlet form $(\mathcal{E}, \mathcal{F})$ on it. We determine the whole dimensional spectrum showing also that the Hausdorff measure of K can be obtained as a residue at a pole $d_D < 2$ of the analytic continuation of the volume-zeta functional of D. We also introduce a natural energy-zeta functional associated with D from which the Dirichlet form can be obtained as a residue at a pole $\delta_D < 2$. We finally study the Connes metric proving that the induced metric on K is bi-Lipshiz with respect to the Euclidean geodesic metric of K. As a last result we prove that the Fredholm module associated with D couples nontrivially with all generators of the K_1-theory group of the gasket. (Received June 29, 2011)

1072-46-255 **Alexander A Katz** (katza@stjohns.edu), St. John's University, SJC, Dep. of Math & CS, 300 Howard Avenue, DaSilva AC 314, Staten Island, NY 10301, and **Oleg Friedman*** (friedman001@yahoo.com), Touro College, NY, USA (current address), University of South Africa, Dep. of Math Sci., P.O.Box 392 UNISA, Pretoria, 0003, South Africa. *GNS type representations and extensions of saturated separating families of regular seminorms from real locally C*-algebras to their enveloping locally C*-algebras.*

GNS type representations of real locally C*-algebras in real and complex locally Hilbert spaces are constructed, and then, as a corollary, a result on the extensions of saturated separating families of regular seminorms on real locally C*-algebras to saturated separating families of regular seminorms on their enveloping locally C*-algebras is obtained. (Received June 29, 2011)

1072-46-265 **Alexander A. Katz** (katza@stjohns.edu), St. John's University, SJC, Dep. of Math & CS, 300 Howard Ave., DaSilva AC 314, Staten Island, NY 10301, **Oleg Friedman** (friedman001@yahoo.com), Touro College, NY, USA (current address), University of South Africa, Dep. of Math Sci., P.O.Box 392 UNISA, Pretoria, 0003, South Africa, **Roman Kushnir** (kushnir_roman@yahoo.com), University of South Africa, Dep. of Mathematical Sciences, P.O.Box 392 UNISA, Pretoria, 0003, South Africa, and **Mark Ustayev*** (mark.uuuu@gmail.com), University of South Africa, Dep. of Mathematical Sciences, P.O.Box 392 UNISA, Pretoria, 0003, South Africa. *Existence and uniqueness of the universal enveloping locally W*-algebra for a locally JBW-algebra.*

Generalizing a theorem Alfsen, Hanche-Olsen and Shultz on existence and uniqueness of the universal W*-algebra for a JBW-algebra it is shown that for each locally JBW-algebra there exists, a unique up to a locally isometric mapping, the universal enveloping locally W*algebra. (Received June 29, 2011)

47 ► Operator theory

1072-47-15 **Joseph A Ball*** (joball@math.vt.edu), Department of Mathematics, Virginia Tech, Blacksburg, VA 24061, and **Moises D Gurerra-Huaman**. *Test functions, kernel functions, interpolation and transfer-function realization for multiplier algebras: the matrix-valued setting.*

The classical Schur class consists of holomorphic functions on the unit disk with values equal to Hilbert space contraction operators. Equivalent characterizations are: norm at most 1 as a multiplier on the Hardy space over the unit disk, positivity of the associated de Branges-Rovnyak kernel, and realization as the transfer function of a dissipative (or even conservative) discrete-time input/state/output linear system. A number of more general settings have now been worked out where these properties are preserved in various forms. One such is the test-function approach where one defines a generalized Schur class as the intersection of the unit balls of the multiplier algebras over the set of all positive kernels for which each function in a preassigned collection of test functions is a contractive multiplier. The main new point addressed in this talk is the extension of this test-function approach to the case where the test functions, kernel functions and Schur-class functions are all allowed to be matrix- or operator-valued. We highlight several concrete examples where this more general setting adds insight beyond that obtained from previous work. (Received May 14, 2011)

1072-47-17 **Ruhan Zhao*** (rzhao@brockport.edu), Department of Mathematics, SUNY Brockport, Brockport, MP 14618, and **Jasbir Singh Manhas** (manhas@squ.edu.om), Department of Mathematics, Sultan Qaboos University, Muscat, Oman. *New estimates of essential norms of weighted composition operators between Bloch type spaces.*

For $\alpha > 0$, the α-Bloch space is the space of all analytic functions f on the unit disk D satisfying

$$\|f\|_{B^\alpha} = \sup_{z\in D} |f'(z)|(1-|z|^2)^\alpha < \infty.$$

Let φ be an analytic self-map of D and u be an analytic function on D. The weighted composition operator induced by u and φ is defined by $uC_\varphi(f)(z) = u(z)f(\varphi(z))$. We give estimates of the essential norms of uC_φ between different α-Bloch spaces in terms of the n-th power of φ. We also give similar characterizations for boundedness and compactness of uC_φ between different α-Bloch spaces. (Received May 16, 2011)

1072-47-34 **Gadadhar Misra*** (gm@math.iisc.ernet.in), Department of Mathematics, Indian Institute of Science, Bangalore, 560012, India, and **Subrata Shyam Roy** and **Genkai Zhang**. *Reproducing kernel for a class of weighted Bergman spaces on the symmetrized polydisc.* Preliminary report.

A natural class of weighted Bergman spaces on the symmetrized polydisc is isometrically embedded as a subspace in the corresponding weighted Bergman space on the polydisc. We find an orthonormal basis for this subspace. It enables us to compute the kernel function for the weighted Bergman spaces on the symmetrized polydisc using the explicit nature of our embedding. This family of kernel functions include the Szego and the Bergman kernel on the symmetrized polydisc. (Received May 29, 2011)

1072-47-37 **Lawrence A Fialkow*** (fialkowl@newpaltz.edu). *Solving multivariable truncated moment problems through positive extensions.* Preliminary report.

For a real n-dimensional multisequence of degree $2d$, $\beta \equiv \{\beta_i\}_{i \in \mathbb{Z}_+^n, |i| \leq 2d}$, we consider the existence of a positive measure μ on $\mathbb{R}^n$ such that $\beta_i = \int x^i d\mu$ ($|i| \leq 2d$). One solution to the preceding Truncated Moment Problem concerns the functional $L_\beta : P_{2d} \longrightarrow \mathbb{R}$ defined by $L_\beta(\sum_{|i| \leq 2d} a_i x^i) = \sum a_i \beta_i$. A result proved with R.E. Curto (2009) shows that β has a measure if and only if L_β admits a positive extension $\tilde{L} : P_{2d+2} \longrightarrow \mathbb{R}$ (i.e., $deg\ p \leq 2d+2$, $p|\mathbb{R}^n \geq 0 \Longrightarrow \tilde{L}(p) \geq 0$). We discuss recent work with J. Nie concerning a numerical test for positivity of the functional. Another approach to TMP concerns extensions of the moment matrix M_d associated to β. β has a measure if and only if there exist positive semidefinite extensions $M_{d+1}, \ldots, M_{d+k}$ such that $rank\ M_{d+k} = rank\ M_{d+k-1}$ (for some $k \geq 1$). We discuss recent work with R.E. Curto illustrating this approach. (Received June 1, 2011)

1072-47-41 **Gelu F Popescu*** (gelu.popescu@utsa.edu). *Composition operators on noncommutative Hardy spaces.*

We initiate the study of composition operators on the noncommutative Hardy space $H^2_{\mathbf{ball}}$. Several classical results about composition operators (boundedness, norm estimates, spectral properties, compactness, similarity) have free analogues in our noncommutative multivariable setting. The most prominent feature of this talk is the interaction between the noncommutative analytic function theory in the unit ball of $B(\mathcal{H})^n$, the operator algebras generated by the left creation operators on the full Fock space with n generators, and the classical complex function theory in the unit ball of $\mathbb{C}^n$. (Received June 09, 2011)

1072-47-51 **Ronald G. Douglas*** (rdouglas@math.tamu.edu), Department of Mathematics, Texas A&M University, TAMU-3368, College Station, TX 77843-3368, and **Kai Wang** (kaiwangmath@gmail.com), Department of Mathematics, Texas A&M University, TAMU-3368, College Station, TX 77843-3368. *Polynomially Weighted Spaces on the Unit Ball in C^n.*

For any probability measure μ on the unit ball in C^n, one can attempt to define a Bergman space which is a subspace of the L^2 space for μ. However, there are several possible definitions for such a space. One would be all functions in $L^2(\mu)$ which are locally equal a.e. to a holomorphic function. A second would be the equivalence classes in $L^2(\mu)$ which contain a holomorphic function on the open ball. Another would be the closure in $L^2(\mu)$ of the polynomials or perhaps the functions holomorphic on a neighborhood of the closure of the ball.

In this talk I discuss a recent result by K. Wang and myself showing that all of these definitions coincide for the measures of the form $d(\mu) = |p|^2 dm$, where m is Lebesgue measure on the ball and p is a polynomial. Moreover, in these cases, the Hilbert module defined by this weighted Bergman space is essentially normal; that is, all of the cross-commutators of the multiplication operators defined by the coordinate functions are compact (actually in the Schatten-von Neumann class). The proofs depend on techniques from harmonic analysis. (Received June 13, 2011)

1072-47-52 **Lewis A Coburn*** (lcoburn@buffalo.edu). *Berezin transform and Weyl-type unitary operators on the Bergman space.*

For $\mathbf{D}$ the open complex unit disc with normalized area measure, we consider the Bergman space $L^2_a(\mathbf{D})$ of square-integrable holomorphic functions on $\mathbf{D}$. Induced by the group $Aut(\mathbf{D})$ of biholomorphic automorphisms of $\mathbf{D}$, there is a standard family of Weyl-type unitary operators on $L^2_a(\mathbf{D})$. For all bounded operators X on $L^2_a(\mathbf{D})$, the Berezin transform $\widetilde{X}$ is a smooth, bounded function on $\mathbf{D}$. The range of the mapping Ber: $X \to \widetilde{X}$ is invariant under $Aut(\mathbf{D})$. The "mixing properties" of the elements of $Aut(\mathbf{D})$ are visible in the Berezin transforms of the induced unitary operators. Computations involving these operators show that there is no real number $M > 0$ with $M\|\widetilde{X}\|_\infty \geq \|X\|$ for all bounded operators X, and are used to check other possible properties of $\widetilde{X}$. Extensions to other domains are discussed. (Received June 13, 2011)

1072-47-59 **Xiang Fang*** (xfang@ksu.edu), 138 Cardwell Hall, Manhattan, KS 66506. *Abstract Fibre Dimension.*

We start with an observation that the fibre dimension, usually defined in a straightforward manner, is not an intrinsic invariant of the underlying Hilbert module. We propose that the appropriate definition is a "relative fibre dimension". I will give three different ways to define it, with one easily generalizing to the Fredholm domain of any operator.

In addition to a general framework, I will also present some more concrete results which appear to be new even for the Dirichlet space over the unit disc. (Received June 14, 2011)

1072-47-72 **Quanlei Fang** and **Jingbo Xia*** (jxia@acsu.buffalo.edu), Department of Mathematics, State University of New York at Buffalo, Buffalo, NY 14260. *Weights and essential normality of polynomial-generated submodule.*

Recently, Douglas and Wang proved that for each polynomial q, the submodule $[q]$ of the Bergman module on the ball generated by q is essentially normal. Using improved techniques, we show that the analogue of this result holds in the case of the Hardy space $H^2(S)$ and in the first non-trivial Drury-Arveson space case H^2_2, and more. More specifically, we consider the family of reproducing-kernel Hilbert spaces $\mathcal{H}^{(t)}$, $-n \leq t < \infty$, where n is the complex dimension of the ball. Here, $\mathcal{H}^{(t)}$ is defined by the reproducing kernel $(1 - \langle \zeta, z\rangle)^{-n-1-t}$, and one can think of the value t as the "weight" for the space $\mathcal{H}^{(t)}$. We show that if $q \in \mathbf{C}[z_1, \ldots, z_n]$, then for each real value $-3 < t < \infty$ the submodule $[q]^{(t)}$ of $\mathcal{H}^{(t)}$ is p-essentially normal for every $p > n$. Applications of this general result to the cases $t = -1$ and $t = -2$ yield the above-mentioned results for $H^2(S)$ and H^2_2 respectively. (Received June 17, 2011)

1072-47-85 **Patrick Cade** (pc388418@albany.edu) and **Rongwei Yang*** (ryang@math.albany.edu), 10 Harmony Court, Cohoes, NY 12047. *A new joint spectrum and cyclic cohomology.* Preliminary report.

For a tuple $A = (A_1,\ A_2,\ ...,\ A_n)$ of elements in a unital algebra $\mathcal{B}$ over $\mathbb{C}$, its *projective spectrum* $P(A)$ is the collection of $z \in \mathbb{C}^n$ such that $A(z) = z_1A_1 + z_2A_2 + \cdots + z_nA_n$ is not invertible in $\mathcal{B}$. $\mathcal{B}$-valued 1-form $A^{-1}(z)dA(z)$ reveals the topology of $P^c(A)$. In fact, it furnishes a homomorphism from the cyclic cohomology of $\mathcal{B}$ to the de Rham cohomology of $P^c(A)$. A particular case of this homomorphism leads to a high order Jacobi's formula. (Received June 20, 2011)

1072-47-91 **Tavan T Trent*** (ttrent@as.ua.edu), Dept. of Mathematics, University of Alabama, Tuscaloosa, AL 35487. *The Douglas Property for Multiplier Algebras.*

Let $\mathcal{H}(\Omega)$ denote a reproducing kernel Hilbert space of functions on Ω with multiplier algebra,$\mathcal{M}(\mathcal{H}(\Omega))$. An algebra, $\mathcal{A}$, of $B(\mathcal{H}(\Omega))$ has the *Douglas property* if whenever $A_{ij}, B_{ij} \in \mathcal{A}$ with $[A_{ij}], [B_{ij}] \in B(\overset{\infty}{\underset{n=1}{\oplus}} \mathcal{H}(\Omega))$ with $[A_{ij}][A_{ij}]^* \geq [B_{ij}][B_{ij}]^*$, then there exists $C_{ij} \in \mathcal{A}$ with $[C_{ij}] \in B(\overset{\infty}{\underset{n=1}{\oplus}} \mathcal{H}(\Omega))$ satisfying:

$$(1) \qquad [A_{ij}][C_{ij}] \ = \ [B_{ij}]$$

$$\text{and} \quad (2) \qquad \|[C_{ij}]\| \ \leq \ 1.$$

For a *nice* kernel, McCullough and I have shown

THEOREM: Assume that $\mathcal{H}(\Omega)$ is *nice*. $\mathcal{H}(\Omega)$ has an NP kernel $\iff$ $\mathcal{M}(\mathcal{H}(\Omega))$ has the *Douglas property*. (Received June 21, 2011)

1072-47-120 **Gabriel T Prajitura*** (gprajitu@brockport.edu), Department of mathematics, College at Brockport, State University of New York, Brockport, NY 14420, and **John B Conway** and **Alejandro Rodriguez-Martinez**. *Similarity of powers and inflations.* Preliminary report.

We will discuss the class of all operators T a on Hilbert spaces for which T^2 is similar to $T \oplus T$ (Received June 24, 2011)

1072-47-122 **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 $A_1, ..., A_n \in \mathfrak{A}$. If the row operator $[A_1, ..., A_n] \in B(H^{(n)}, H)$ 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 June 24, 2011)

1072-47-180 **Greg Knese*** (geknese@bama.ua.edu), University of Alabama, Dept. of Mathematics, 345 Gordon Palmer Hall, Box 870350, Tuscaloosa, AL 354870350. *Schur-Agler class rational inner functions on the tridisk.*

The Schur-Agler class is a natural class of bounded analytic functions on the polydisk studied for its connection to multivariable von Neumann inequalities. We discuss some recent results showing the inclusion of certain low degree rational inner functions in this class. We also discuss how these problems establish a close relationship to the problem of representing a positive trigonometric polynomial as a sum of squares. (Received June 27, 2011)

1072-47-217 **Daniel Hans Lenz***, daniel.lenz@uni-jena.de. *Eigenfunction expansions for general Laplacians.*

We provide an expansion in generalized eigenfunctions for self-adjoint operators on a separable Hilbert space. In our setting a suitable space of generalized eigenfunctions to a fixed energy is given a Hilbert space structure yielding a direct integral decomposition of the original Hilbert space. For Laplacians on graphs and more generally metric measure spaces we can study decay properties of a natural orthonormal basis of generalized eigenfunctions for each fixed energy. (Based on joint work with Alexander Teplyaev) (Received June 28, 2011)

1072-47-258 **Stefan Richter*** (richter@math.utk.edu) and **Carl Sundberg**. *Remarks about cyclic vectors in the Drury Arveson space.* Preliminary report.

Let H^2_d denote the Drury Arveson space of the open unit ball B_d of $\mathbb{C}^d$. A function $f \in H^2_d$ is called cyclic, if there is a sequence of polynomials p_n such that $p_n f \to 1$. We show that for $d \leq 2$ a polynomial is cyclic, if and only if it has no zeros in B_d. For $d \geq 4$ there are noncyclic polynomials with no zeros in B_d. The case $d = 3$ is open. (Received June 29, 2011)

1072-47-261 **Carl Sundberg*** (sundberg@math.utk.edu). *Cyclic Vectors in Spaces of Analytic Functions on the Ball.* Preliminary report.

We investigate questions concerning cyclic vectors in the "standard scale" of rotationally invariant Hilbert spaces of analytic functions in the unit ball in several complex variables. This is joint work with Stefan Richter. (Received June 29, 2011)

49 ► Calculus of variations and optimal control; optimization

1072-49-42 **Nageswari Shanmugalingam*** (shanmun@uc.edu), Department of Mathematical Sciences, P.O. Box 210025, University of Cincinnati, Cincinnati, OH 45221-0025, and **Juha Kinnunen**, **Riikka Korte** and **Andrew Lorent**. *Regularity of sets with quasiminimal boundary surfaces in metric measure spaces.*

DeGiorgi proved that Euclidean minimal surfaces are regular outside a subset of codimension at least 2. This result was extended by David and Semmes, who showed that Euclidean sets with quasiminimal boundary surfaces are rectifiable and are locally uniform domains as their interior. In this talk we will describe analogs of the result of Davi and Semmes in the setting of metric measure spaces with doubling measures supporting a 1-Poincaré inequality. These results are applied to the study of quasiminimal surfaces in weighted Euclidean spaces with strong A_∞-weights. This is based on joint work with Juha Kinnunen, Riikka Korte, and Andrew Lorent. (Received June 09, 2011)

1072-49-81 **Aaron Luttman*** (aluttman@clarkson.edu), 10 Clarkson Ave., Box 5815, Potsdam, NY 13699, and **Johnathan Bardsley**. *A Projected Lagged-Diffusivity Fixed Point Iteration for Poisson Likelihood Image Deblurring.*

Image deblurring problems are usually formulated as linear operator equations of the form $Au = z$, where z is the measured image, A is the image blurring operator based on the (measured) point-spread function, and u is the ideal image that one wishes to reconstruct. Rather than computing u using a least-squares approach, one can instead compute a minimizer of

$$E(u) = \int_\Omega (Au + \gamma - z \log(Au + \gamma))\, d\Omega,$$

where $\Omega \subset \mathbb{R}^2$ is the image domain and $\gamma > 0$ is the expectation of a Poisson random variable describing the background radiation. This approach allows one to take into consideration the Poisson nature of two of

the three primary errors involved. We present a reconstruction algorithm based on the lagged diffusivity fixed point iteration that combines a quasi-Newton iteration with projection onto the non-negativity constraints for computing an approximate minimizer to the above functional and show results on synthetic astronomical imagery. (Received June 20, 2011)

51 ► Geometry

1072-51-22 **Sam Northshield*** (northssw@plattsburgh.edu), Dept. of Mathematics, SUNY, 101 Broad St., Plattsburgh, NY 12901. *Continued fractions and the Sierpinski gasket.* Preliminary report.

The continued fraction algorithm, thought of as iteration of the Gauss map $\{1/x\}$ on the unit interval, is equivalent (by conjugation via Minkowski's question mark function, ?(x)) to the iteration of a certain function, f(x), that is easily understood in terms of the binary expansion of x. The Sierpinski gasket is a natural generalization of the unit interval (up one dimension) and the iteration of f(x) can be generalized accordingly. We shall discuss the geometry involved as well generalize the concepts of rational number, quadratic surd, ?(x), Ford circles, continued fractions, and some of the theorems that connect them. (Received May 20, 2011)

1072-51-47 **Jonas Aziz Azzam*** (jonasazzam@math.ucla.edu) and **Raanan Schul** (schul@math.sunysb.edu). *Quantitative Implicit Function and Extension Theorems for Lipschitz Maps.*

We discuss recent work with Raanan Schul. "All Lipschitz maps from R^7 to R^3 are orthogonal projections". This is of course quite false as stated. There is, however, a surprising grain of truth in this statement.

We show that all Lipschitz maps rom R^7 to R^3 (with 3-dimensional image) can be precomposed with a map $g : R^7 \to R^7$ such that $f \circ g$ will satisfy, when we write the domain as $R^4 \times R^3$ and restrict to E, a large portion of the domain, that $f \circ g$ will be constant in the first coordinate and bi-Lipschitz in the second coordinate. Geometrically speaking, the map g distorts R^7 in a controlled manner, so that the fibers of f are straightened out. Moreover, the target space can be replaced by any metric space!

Our results are quantitative. The size of the set E is an important part of the discussion, and examples such as Kaufman's 1979 construction of a singular map of $[0, 1]^3$ onto $[0, 1]^2$ are motivation for our estimates.

On route we will discuss an extension theorem which is used to construct the bi-Lipschitz map g. We show that for any $f : [0, 1]^n \to R^D$ whose image has positive content, one may extend f from a large subset of its domain to a global bi-Lipschitz map $F : R^n \to R^D$. (Received June 12, 2011)

1072-51-96 **Max Lipyanskiy*** (mlipyan@math.columbia.edu), Department of Mathematics Columbia University, Room 509, MC 4406, 2990 Broadway, New York, NY 10027. *Semi-Infinite Cycles in Floer Theory.*

We will survey the realization of various versions of Floer homology as a theory of semi-infinite cycles. (Received June 22, 2011)

1072-51-98 **Sobhan Seyfaddini*** (sobhan.sey@gmail.com). *C^0-limits of Hamiltonian flows and the Oh-Schwarz spectral invariants.*

After briefly reviewing the Oh-Schwarz spectral invariants, we will write down an estimate, which under certain assumptions, relates the spectral invariants of a Hamiltonian to the C^0-distance of its flow from the identity. We will also show that, unlike the Hofer norm, the spectral norm is C^0-continuous on surfaces. Time permitting, we will present applications to the theory of Calabi quasimorphisms. (Received June 22, 2011)

1072-51-111 **Milena D Pabiniak*** (mdp72@cornell.edu). *Lower bounds for Gromov width of coadjoint orbits in U(n).*

We use the Gelfand Tsetlin pattern to construct an effective Hamiltonian, completely integrable action of a torus $T = T^D$ on an open dense subset of a coadjoint orbit of $U(n)$ and we obtain a proper Hamiltonian T-manifold centered around a point in $\mathfrak{t}^*$. The result of Karshon and Tolman says that such a manifold is equivariantly symplectomorphic to a particular subset of $\mathbb{R}^{2D}$. This fact enables us to construct symplectic embeddings of balls into a class of coadjoint orbits of $U(n)$ and therefore obtain a lower bound for their Gromov width. Using the identification of $\mathfrak{u}(n)^*$ with the space of $n \times n$ Hermitian matrices, the main theorem states that for a coadjoint orbit through $\lambda = \mathrm{diag}(\lambda_1, \ldots, \lambda_n) \in \mathfrak{u}(n)^*$, with $\lambda_1 > \lambda_2 > \ldots > \lambda_l = \lambda_{l+1} = \ldots = \lambda_{l+s} > \lambda_{l+s+1} > \ldots > \lambda_n$, $s \geq 0$, the lower bound for Gromov width is equal to the minimum of differences $\lambda_i - \lambda_j$, over all $\lambda_i > \lambda_j$. For a generic orbit, with additional integrality conditions, this minimum was proved to be exactly the Gromov width of the orbit. For nongeneric orbits this lower bound is new. (Received June 23, 2011)

1072-51-145 **Nina Juliana White*** (whitenj@umich.edu). *Bounds on eigenvalues of the Laplacian for certain hyperbolic* 3*–manifolds.*

I'll sketch a proof of the following: in the presence of bounds for the rank of the fundamental group and the injectivity radius, the kth eigenvalue of the Laplacian of a closed hyperbolic 3-manifold M is bounded from above and below by a multiple of $\mathrm{vol}(M)^{-2}$. (Received June 26, 2011)

1072-51-184 **Shuguang Wang*** (wangs@missouri.edu). *On taut, tight foliations and calibrations.*

We give some remarks on the characteristic classes of foliations and related problems. (Received June 27, 2011)

1072-51-187 **Selman Akbulut*** (akbulut@math.msu.edu), MSU, Dept of Mathematics, E.Lansing, MI 48824. *Associative submanifolds of a G_2 manifold.*

The deformation space of an associative submanifold $Y^3 \subset X^7$ in a G_2 manifold (X, φ) is locally given by the kernel of the associated Dirac operator (McLane), in a manifold with G_2 structure (i.e. when φ is not required to be harmonic) it is given by the kernel of the twisted Dirac operator (Akbulut-Salur). We will discuss various notions of deforming Y so that the deformation space becomes smooth. We can either deform Y through pseudo-associstive manifolds , i.e. deforming the Gauss map (Akbulut-Salur), or by allowing φ to deform through closed positive 3-forms (D.Gayet). We will discuss ways to impose compactness by the aid of 2-framed fields.
(Received June 27, 2011)

1072-51-210 **Benjamin Jurke*** (bjurke@gmx.de). *Line bundle valued sheaf cohomology on toric varieties.*

Non-standard techniques for the computation of line bundle valued sheaf cohomology group dimensions on toric varieties are presented. Those methods can also be extended to compute the cohomology group dimensions on quotient spaces of finite group action. Some applications are discussed. (Received June 28, 2011)

1072-51-225 **Jay Wilkins*** (wilkins@math.utk.edu), Department of Mathematics, University of Connecticut, 196 Auditorium Rd, Storrs, CT 06269-3009, and **Conrad Plaut** (cplaut@math.utk.edu), Department of Mathematics, 227 Ayres Hall, 1403 Circle Drive, Knoxville, TN 37996-1320. *The Homotopy Critical Spectrum of a Metric Space II.*

This talk is a continuation of Plaut's earlier talk, and attending that talk is recommended in order to see the basic construction. In this talk I will describe what is known in the non-geodesic case. In general, Homotopy Critical values come in four flavors (v.s. only one for geodesic spaces), and the connection to the topology of the underlying space is more tenuous without additional assumptions, specifically a notion of "refinability". I will discuss several examples to illustrate this and present what is known about the Homotopy Critical Spectrum for resistance metrics, especially the question of refinability of resistance metrics. I will also discuss some results regarding critical values and topological structure of Gromov-Hausdorff limits of general metric spaces, which include many metric fractals that arise in applications. (Received June 28, 2011)

1072-51-246 **Tamar Friedmann*** (tamarf1@yahoo.com). *From singularities to algebras to pure Yang-Mills with matter.*

Since the advent of dualities in string theory, it has been well-known that codimension 4 orbifold singularities that appear in extra-dimensional spaces, such as Calabi-Yau or G_2 spaces, may be interpreted as ADE gauge theories. As to orbifold singularities of higher codimension, there has not been an analog of this interpretation. In this lecture, I will show how the search for such an analog led me from the singularities to the creation of Lie Algebras of the Third Kind ("LATKes"). I will introduce an example of a LATKe that arises from the singularity C^3/Z_3, and prove it to be simple and unique. I will explain that the uniqueness of the LATKe serves as a vacuum selection mechanism. I will also show how the LATKe leads to a new kind of gauge theory in which the matter field arises naturally and which is tantalizingly close to the Standard Model of particle physics.
(Received June 29, 2011)

1072-51-264 **Bianca Santoro*** (bsantoro@ccny.cuny.edu), NEW YORK, NY. *Complete Ricci-flat Kahler metrics on resolutions of singularities.*

In addition to explaining all the words in the title, we will discuss some existence results for complete Calabi-Yau metrics on crepant resolutions of singularities, and as an application, show some non-trivial examples of Ricci-flat manifolds. (Received June 29, 2011)

53 ► Differential geometry

1072-53-7 **Yi Li*** (yili@math.harvard.edu), Department of Mathematics, Science Center, One Oxford Street, Cambridge, MA 02138. *Eigenvalues under the Ricci flow coupled with the harmonic map flow.* Preliminary report.

In this talk we discuss the eigenvalues and entropy under the Ricci flow coupled with the harmonic map flow(RH flow). We give an alternative proof of results for compact steady and expanding RH breathers. In the second part, we derive some monotonicity formulas for eigenvalues of Laplacian under the RH flow. At the end, we obtain the first variation of the shrinker and expanding entropys for the RH flow. (Received March 29, 2011)

1072-53-39 **Joanna Nelson*** (nelson@math.wisc.edu). *Cylindrical contact homology for links of simple singularities.* Preliminary report.

Simple singularities are given as the isolated double point quotient singularity of $\mathbb{C}^2/G$, where G is a finite subgroup of SU_2. The variety $\mathbb{C}^2/G$ may be realized as a hypersurface $f_G^{-1}(0) \subset \mathbb{C}^3$. An associated object of interest is the link L of a simple singularity, given by $S^5 \cap f_G^{-1}(0)$. One can demonstrate that S^3/G and the link L equipped with their standard contact structures are contactomorphic. I'll briefly recall the notion of a simple singularity and then sketch a hopeful means of computing the cylindrical contact homology of S^3/G. This is done by constructing Hamiltonian vector fields on S^2, invariant under the action of G. Since the Hopf fibration is an example of a prequantization space one is able to perturb the contact form on S^3 by lifting the invariant Hamiltonian, and understand the perturbed Reeb dynamics in terms of the original and the horizontal lift of the Hamiltonian vector field on S^2. (Received June 22, 2011)

1072-53-54 **Ioana Suvaina*** (ioana.suvaina@vanderbilt.edu), 1326 Stevenson Center, Department of Mathematics, Vanderbilt University, Nashville, TN 37240. *On symmetries and invariant Einstein metrics on 4-manifolds.*

The existence or non-existence of Einstein metrics on 4-manifolds is strongly related to the differential structure considered. For a large class of non-spin 4-manifolds with the canonical smooth structure, we show that there are infinitely many, non-equivalent smooth free actions of finite cyclic groups. Moreover, we show that there are no invariant Einstein metrics on these manifolds. On manifolds with small topology, we analyze the dependency of the existence of Einstein metrics on the smooth structure considered on the underlying topological space.

The main techniques used come from Seiberg-Witten theory, the geometry of complex surfaces and symplectic topology. (Received June 28, 2011)

1072-53-62 **Artem Pulemotov*** (artem@math.uchicago.edu), Department of Mathematics, The University of Chicago, 5734 South University Avenue, Chicago, IL 60637. *Prescribed Ricci curvature on a solid torus.*

We will discuss the prescribed Ricci curvature equation $\mathrm{Ric}(G) = T$ on a solid torus $\mathcal{T}$ under natural boundary conditions. The unknown G here is a Riemannian metric. The letter T in the right-hand side denotes a (0,2)-tensor on $\mathcal{T}$. We will assume T is nondegenerate (in fact, even a lighter assumption would suffice). Our goal will then be to settle the questions of the existence and the uniqueness of solutions in the class of rotationally symmetric Riemannian metrics on a neighborhood of the boundary of $\mathcal{T}$. (Received June 15, 2011)

1072-53-65 **Ovidiu Munteanu*** (omuntean@math.columbia.edu), Columbia University, New York, NY 10027. *Smooth metric measure spaces.*

I will describe joint work with Jiaping Wang about the structure of complete smooth metric measure spaces with Bakry-Emery curvature bounded below. Applications to gradient Ricci solitons will also be mentioned in the talk. (Received June 15, 2011)

1072-53-67 **Peng Lu*** (penglu@uoregon.edu), Department of Mathematics, University of Oregon, Eugene, OR 97405. *Convergence of fundamental solutions of linear parabolic equations under Cheeger-Gromov convergence.*

In this talk we show the convergence of the fundamental solutions of the parabolic equations assuming the Cheeger-Gromov convergence of the underlying manifolds and the uniform L^1-bound of the solutions. We also prove a local integral estimate of fundamental solutions. (Received June 16, 2011)

1072-53-70 **Guoyi Xu*** (guoyixu@math.uci.edu), 340 Rowland Hall, university of California, Irvine, CA 92697. *Short-time existence of the Ricci flow on noncompact Riemannian manifolds.*

Using the local Ricci flow, we prove the short-time existence of the Ricci flow on noncompact manifolds, whose Ricci curvature has global lower bound and sectional curvature has only local average integral bound. The

short-time existence of the Ricci flow on noncompact manifolds was studied by Wan-Xiong Shi in 1990s, who required a point-wise bound of curvature tensors. As a corollary of our main theorem, we get the short-time existence part of Shi's theorem in this more general context. (Received June 16, 2011)

1072-53-86 **Zhou Zhang*** (zhangou@maths.usyd.edu.au), Zhou Zhang, Carslaw Building, School of Mathematics and Statistics, University of Sydney, NSW 2006, Australia. *Spatial Asymptotic Behaviors of Kähler-Ricci Flows and Kähler-Einstein Metrics over Quasi-Projective Manifolds.* Preliminary report.

In this joint project with Frederic Rochon, we further study the Kähler-Ricci flow and Kähler-Einstein metrics in the quasi-projective setting, $X = \overline{X} \setminus D$ with D having at most normal crossings as singularity and the tranversal direction being Poincare metric asymptotically. This is the classic setting already studied by many people. In our work, the notion of manifold with corners is seriously involved when coming to describe the spatial asymptotic behaviors of the solutions for these geometric PDEs. For the Kähler-Einstein metrics, one needs to consider polyhomogeneous expansions (involving logarithmic terms in general) for a precise desciption at the asymptotic boundary. (Received June 20, 2011)

1072-53-93 **Hongxin GUO*** (hongxin.guo@uni.lu). *Martingales on manifold with time dependent metrics.* Preliminary report.

Arnaudon, Coulibaly and Thalmaier introduced g(t)-Brownian motion on manifold with time dependent metrics, and showed applications to the Ricci flow. In this talk we attempt to generalize g(t)-Brownian motion to martingales on manifold with changing metrics. We are in particular interested in the applications to the Ricci flow. (Received June 22, 2011)

1072-53-119 **Yi Lin*** (yilin@georgiasouthern.edu), 65 Georgia Ave. Room 3008, Statesboro, GA 30458. *Symplectic harmonic Thom forms.* Preliminary report.

Consider the symplectic Harmonic Thom forms of an oriented submanifold of a symplectic manifold. It was shown by Bahramgiri that the symplectic harmonic Thom forms of co-isotropic and symplectic submanifolds exhibit interesting properties very different from Riemannian Harmonic forms. In particular, when the submanifold is co-isotropic, the symplectic harmonic form is supported in a tubular neighborhood of the submanifold; and when the submanifold is symplectic, its symplecitc harmonic form is supported everywhere on the ambient symplectic manifold. In this talk, I will give a quick introduction to symplectic hodge theory and explain the main ideas involved in the work of Bahramgiri. I will then discuss what I know about the symplectic harmonic forms of isotropic submanifolds. (Received June 23, 2011)

1072-53-134 **Tara S Holm*** (tara.holm@cornell.edu), Department of Mathematics, Cornell University, Ithaca, NY 14850, and **Ana Rita Pires**. *Morse theory and symplectic origami.*

We give a brief introduction to symplectic origami, which are a special case of folded symplectic manifolds. We then discuss how Morse theory techniques may be adapted to the origami situation. Main results will be illustrated by examples. (Received June 25, 2011)

1072-53-144 **Jeanne Clelland*** (Jeanne.Clelland@colorado.edu), Dept. of Mathematics, 395 UCB, Boulder, CO 80305. *Equivalence of geometric structures in control theory via moving frames.* Preliminary report.

The method of equivalence was introduced by Elie Cartan in 1908 as a procedure for finding invariants of geometric structures under the actions of pseudogroups, which most commonly appear as subgroups of the diffeomorphism group of a manifold preserving some underlying geometric structure. The method was further developed and systematized over the course of the 20th century, and it has been applied in a great variety of contexts.

After briefly demonstrating Cartan's method in the familiar context of Riemannian geometry, we will describe applications of the method of equivalence to some geometric structures related to control theory:

1) Sub-Riemannian geometry (Hughen, Moseley) and sub-Finsler geometry (C—, Moseley, and Wilkens), both of which involve metrics which are defined only on a distribution on a manifold (i.e., on a subbundle of the tangent bundle of the manifold). Such metrics appear naturally in the context of optimal control of "driftless" kinematic systems.

2) Affine distributions (C—, Moseley, and Wilkens), which appear naturally in the contexts of kinematic control systems with drift and dynamic control systems. (Received June 26, 2011)

1072-53-147 **Victor Guillemin**, **Eva Miranda** and **Ana Rita Pires*** (arita@math.mit.edu), 129 Chestnut St., Cambridge, MA 02139. *Symplectic Geometry on b-manifolds.* Preliminary report.

In 2002, Radko completely classified the Poisson structures on a surface that vanish transversally on a union of curves. For higher dimensional manifolds, this notion generalizes to the top power of the Poisson bivector vanishing transversally on a union of hypersurfaces, and is the analogue of being symplectic when one uses the b-tangent and b-cotangent bundles introduced by Melrose, Nest and Tsygan originally in the context of manifolds with boundary. In this talk we will see what classification results can be obtained for these higher dimensional "symplectic b-manifolds", and how they extend Radko's result for surfaces. (Received June 30, 2011)

1072-53-154 **Timothy Nguyen*** (timothyn@math.mit.edu). *Lagrangians from Seiberg-Witten theory.*

We discuss how boundary values of the space of solutions to the Seiberg-Witten equations, both on compact 3-manifolds and on 3-manifolds with cylindrical ends, yield Lagrangian submanifolds within the corresponding boundary configuration space. In the case of cylindrical ends, this construction provides a Lagrangian correspondence between the vortex moduli spaces at infinity. As an application, we discuss work in progress for supplying the analytic details of Donaldson's TQFT proof of the Seiberg-Witten invariants of a closed 3-manifold. (Received June 26, 2011)

1072-53-192 **Marta Lewicka**, Department of Mathematics, Rutgers University, and **Reza Pakzad*** (pakzad@pitt.edu), Department of Mathematics, Univeristy of Pittsburgh, Pittsburgh, PA 15260. *Matching and density properties of infinitesimal isometries on 2d surfaces.*

An infinitesimal isometry of order n of a given surface is a one parameter family of deformations u_t whose induced change of metric is of order t^{n+1}. Sobolev isometries and infinitesimal isometries arise in the study of nonlinear elasticity of thin plates and shells. An important property of these deformations in this context is their matching properties: Can an infinitesimal isometry of order n be modified in a controlled manner to yield one of order $m > n$? The answers much depend on the analytical and geometrical properties of the surface and the regularity of the given deformation and has consequences for the elastic properties of the surface. We will review some recent and past results and discuss some open problems. (Received June 27, 2011)

1072-53-205 **Joerg Enders*** (joerg.enders@uni-potsdam.de). *Blow-ups of Type I Ricci flows.*

Hamilton conjectured that singularities of Ricci flow should be modeled by non-flat shrinking solitons because of the scaling and diffeomorphism invariance of the equation. Based on the monotonicity and scaling behavior of Perelman's reduced volume functional, we will give a proof of Hamilton's conjecture for the case of Type I Ricci flows and discuss applications regarding the curvature blow-up and partial regularity in this situation. This is joint work with Reto Müller and Peter Topping. (Received June 28, 2011)

1072-53-211 **Brett Kotschwar*** (brett.kotschwar@aei.mpg.de). *Some problems of unique continuation arising in the study of geometric evolution equations.*

We describe some geometric applications of recent work on unique continuation problems for nonlinear weakly-elliptic and weakly-parabolic systems to the study of the Ricci and mean-curvature flows. (Received June 28, 2011)

1072-53-213 **Thomas A Ivey***, Department of Mathematics, College of Charleston, 66 George St., Charleston, SC 29424. *Austere Hypersurfaces in Complex Projective Space.* Preliminary report.

A submanifold M for in Euclidean space $\mathbb{R}^n$ is austere if all odd-degree symmetric polynomials in the eigenvalues of the second fundamental form (in any normal direction) vanish. Harvey and Lawson showed that this condition is necessary and sufficient for the normal bundle of M to be special Lagrangian in $T\mathbb{R}^n \cong \mathbb{C}^n$. A similar result was proved by Karigiannis and Min-Oo for S^n, with TS^n carrying a Calibi-Yau metric due to Stenzel.

In this preliminary report we investigate conditions under which the normal bundle of a submanifold in $\mathbb{C}P^n$ is special Lagrangian with respect to the Stenzel metric on $T\mathbb{C}P^n$. (Received June 28, 2011)

1072-53-214 **Albert J Todd*** (ajtodd83@gmail.com). *Moduli Spaces of Asymptotically Cylindrical Special Lagrangian Submanifolds.*

The goal of this talk is to show that the space of local deformations of an asymptotically cylindrical special Lagrangian submanifold is a smooth finite-dimensional manifold for almost all decay rates of the submanifold. After a bit of background on this problem, I will discuss Calabi-Yau and special Lagrangian geometry as well as give an introduction to the analysis on asymptotically cylindrical manifolds required to solve this problem; finally, I will explicitly calculate the admissible decay rates and outline the argument to show the desired results

on the moduli space. Time permitting, I will briefly describe applications of this result. (Received June 28, 2011)

1072-53-222 **Albert Chau*** (chau@math.ubc.ca). *Lagrangian mean curvature flow for entire graphs.*
I will discuss results on the existence of longtime smooth solutions for mean curvature flow of entire Lipschitz Lagrangian graphs. Entire self similar solutions to the Lagrangian mean curvature flow are also discussed. The talk is based on joint work with Jingyi Chen and Yu Yuan. (Received June 28, 2011)

1072-53-224 **Conrad Plaut*** (cplaut@math.utk.edu), Mathematics Department, Ayres Hall 227, Knoxville, TN 37996, and **Jay Wilkins** (wilkins@math.utk.edu), Department of Mathematics, University of Connecticut, 196 Auditorium Rd, Storrs, CT 06269-3009. *The Homotopy Critical Spectrum of a Metric Space I.*
Using the methods of discrete chains and homotopies developed by Berestovskii-Plaut, we define the Homotopy Critical Spectrum of a metric space. Like the Covering Spectrum defined by Sormani-Wei, the Homotopy Critical Spectrum consists of positive numbers that measure quantitatively when the topological type of covering maps of the space changes. However, unlike the work of Sormani-Wei, which utilizes a classical construction of Spanier and requires a geodesic space, our construction works for arbitrary metric spaces, including non-geodesic metrics such as resistance metrics. Discrete methods also have proved useful in considering questions of Gromov-Hausdorff convergence. In this talk I will describe discrete paths and homotopies, and the construction of ϵ-covers. I will discuss what is known for geodesic spaces, including the simple relationship between the Covering and Homotopy Critical Spectra, connections to the spectrum of the Laplacian, and some new results, including determination of the Homotopy Critical Spectrum by "essential circles", stability under Gromov-Hausdorff Convergence, and finiteness theorems. (Received June 28, 2011)

1072-53-230 **F. Arikan** (arikan@math.rochester.edu), Rochester, NY 14620, **H. Cho*** (cho@math.rochester.edu), Rochester, NY 14620, and **S. Salur** (salur@math.rochester.edu), Rochester, NY 14620. *Existence of compatible contact structures on G_2-manifolds.*
In this note, we show the existence (co-oriented) contact structures on certain classes of G_2-manifolds, and that these two structures are compatible in certain ways. We also prove that any seven-manifold with a spin structure has an almost contact structure, and construct explicit almost contact structures on manifolds with G_2-structures. Moreover, we also show that one can extend any almost contact structure on an associative submanifold to whole G_2-manifold. (Received June 28, 2011)

1072-53-248 **Jeffrey S Case*** (jscase@math.princeton.edu), Fine Hall, Washington Road, Princeton, NJ 08544. *Conformal geometry and quasi-Einstein metrics.*
Quasi-Einstein metrics are a broad class of metrics which include Einstein metrics and gradient Ricci solitons. Except for gradient Ricci solitons, they can be naturally viewed as objects in conformal geometry. Moreover, many of the tools used to study gradient Ricci solitons can be realized from this conformal viewpoint. In this talk, we will describe how the conformal perspective yields an equivalence between quasi-Einstein metrics and sections of a certain vector bundle, and use this to draw some conclusions about such metrics. We will also use this to give a new heuristic for the study of gradient Ricci solitons. In particular, this will yield a necessary and sufficient condition for a suitably generic metric to be a gradient Ricci soliton. (Received June 29, 2011)

1072-53-256 **William Wylie***, Math Department, 215 Carnegie Building, Syracuse University, Syracuse, NY 13244. *Warped Product Einstein metrics and Ricci solitons.*
We will discuss recent results on warped product Einstein metrics and their application to Ricci solitons. This is joint work with Chenxu He and Peter Petersen. (Received June 29, 2011)

1072-53-259 **Sema Salur*** (salur@math.rochester.edu), University of Rochester, Department of Mathematics, Rochester, NY 14627. *Calibrations and Manifolds with Special Holonomy.* Preliminary report.
Examples of n-dimensional Ricci flat manifolds are Riemannian manifolds whose holonomy groups Hol(g) are subgroups of SU(n), for n=2m, and subgroups of the exceptional Lie group G_2, for n=7. We call them Calabi-Yau and G_2 manifolds, respectively. They are also examples of manifolds with special holonomy.

Calibrated submanifolds of Calabi-Yau and G_2 manifolds are volume minimizing in their homology classes and their moduli spaces have many important applications in geometry, topology and physics.

In this talk we give an introduction to calibrated geometries and a report of recent research on the calibrations inside the manifolds with special holonomy. (Received June 29, 2011)

1072-53-262 **Susan Tolman*** (stolman@math.uiuc.edu), University of Illinois at Urbana-Champaign, Urbana, IL 61801. *On the integer cohomology of Hamiltonian GKM manifolds.*

Let a torus T act in a Hamiltonian fashion on a compact symplectic manifold (M, ω). We will say that M is a Hamiltonian GKM manifold if the fixed point set M^T is discrete and the submanifold M^H fixed by each codimension one subtorus $H \subset T$ has dimension at most two. In this case, it is well known that the rational (equivariant) cohomology and Chern class are determined by a certain associated graph. The purpose of this talk is to show that the same claim holds over the integers.

This is a special case of a much more general theorem, which holds whenever the integer cohomology of the fixed point set is torsion free. (Received June 29, 2011)

54 ► General topology

1072-54-4 **Katrin Wehrheim*** (wehrheim@mit.edu), 77 Mass Ave, Cambridge, MA 02139. *How to construct topological invariants via decompositions and the symplectic category.*

A Lagrangian correspondence is a Lagrangian submanifold in the product of two symplectic manifolds. This generalizes the notion of a symplectomorphism and was introduced by Weinstein in an attempt to build a symplectic category. In joint work with Chris Woodward we define such a category in which all Lagrangian correspondences are composable morphisms. We extend it to a 2-category by extending Floer homology to cyclic sequences of Lagrangian correspondences. This is based on counts of 'holomorphic quilts' - a collection of holomorphic curves in different manifolds with 'seam values' in the Lagrangian correspondences. A fundamental isomorphism of Floer homologies ensures that our constructions are compatible with the geometric composition of Lagrangian correspondences. This provides a general prescription for constructing topological invariants by decomposition into simple pieces and a partial functor into the symplectic category (which need only be defined on simple pieces; with moves corresponding to geometric composition). (Received June 23, 2011)

1072-54-99 **Thomas Kragh*** (tkragh@math.mit.edu). *Fibrancy of Symplectic Homology in Cotangent Bundles.*

Let M be any exact sub-Liouville domain of a cotangent bundle T^*N. In this talk I will describe how the symplectic homology of M in a sense is "fibrant" over the base N, and how this implies that there is a Serre type spectral sequence with product converging to the symplectic homology ring of M. In particular this implies that for a closed exact Lagrangian in T^*N this spectral sequence converges to the loop space homology of L equipped with the Chas-Sullivan string product. This puts restrictions on L and in fact proves that up to a finite covering space lift of N the map $L \to T^*N \to N$ is a homology equivalence. (Received June 22, 2011)

1072-54-130 **Andrea Medini*** (medini@math.wisc.edu) and **David Milovich** (david.milovich@tamiu.edu). *The topology of ultrafilters as subsets of 2^ω.*

By identifying a subset of ω with an element of the Cantor set 2^ω in the obvious way, it is possible to study the topological properties of any $\mathcal{X} \subseteq \mathcal{P}(\omega)$. We will focus on the case $\mathcal{X} = \mathcal{U}$, where $\mathcal{U}$ is a non-principal ultrafilter on ω. It is easy to see that there are $2^\mathfrak{c}$ non-homeomorphic ultrafilters. However, the proof is based on a cardinality argument, hence it is not 'honest' in the sense of Van Douwen: it would be desirable to find 'quotable' topological properties that distinguish ultrafilters up to homeomorphism. We present (at least consistently) two such topological properties. (Received June 24, 2011)

55 ► Algebraic topology

1072-55-194 **Jeremy T Brazas*** (jtv5@unh.edu). *Semicoverings: A generalization of covering space theory.*

One may consider the finest group topology on the fundamental group of a space for which the map from the loop space identifying homotopy classes is continuous. This "topological" fundamental group remembers local structures of spaces forgotten by weak homotopy type and, it turns out, is intimately related to the theory of free topological groups. In this talk, I will discuss a generalization of the classical theory of covering spaces in the context of these topologized fundamental groups and mention potential applications to the theory of topological groups. (Received June 27, 2011)

1072-55-196 **Bernard Badzioch*** (badzioch@buffalo.edu) and **Wojciech Dorabiala** (wud2@psu.edu). *Secondary transfer and higher torsion.*

Higher torsion invariants are invariants of bundles of smooth manifolds that can distinguish between bundles that are not diffeomorphic even if they are fiberwise homotopy equivalent. The talk will describe a construction of higher torsion by means of the secondary transfer of bundles. I will also explain how this approach to higher torsion provides an insight into some of its properties. (Received June 27, 2011)

1072-55-226 **James Belk** and **Bradley Forrest*** (bradley.forrest@stockton.edu), Mathematics Program, P.O. Box 195, Jimmie Leeds Road, Pomona, NJ 08240. *P-adic and Universal Hyperbolic Solenoids.*

A solenoid is an inverse limit of connected Hausdorff spaces and covering maps indexed over a directed set. In this talk, I will investigate the algebraic topology of two well known solenoids, the P-adic solenoid and the universal hyperbolic solenoid. I will discuss joint work with James Belk, which generalizes a theorem of Odden on the universal hyperbolic solenoid. Specifically, I will present an isomorphism between the group of basepoint preserving homotopy self equivalences of a solenoid and the automorphism group of the fundamental pro-group of the solenoid. (Received June 28, 2011)

1072-55-229 **Courtney Morris Thatcher*** (courtney.thatcher@simons-rock.edu), Bard College at Simon's Rock, 84 Alford Road, Great Barrington, MA 01230. *On classifying free $\mathbb{Z}/p\mathbb{Z}$ actions on $S^n \times S^m$.*

We consider the quotients of a free large prime cyclic group actions on $S^n \times S^m$. For n and m both odd, a quotient is equivariantly homotopy equivalent to one resulting from a linear action. For n odd and m even, there are nonlinear possibilities for the underlying equivariant homotopy type. In this talk we will discuss the differences between the homotopy types of the two cases as well as the classification of fake quotients in both cases. In the odd spheres case, the ρ-invariant vanishes and the Pontrjagin classes become p-localized homeomorphism invariants for a given dimension. The ρ-invariant does not vanish in the odd and even sphere case, however. (Received June 28, 2011)

1072-55-238 **Brenda Johnson*** (johnsonb@union.edu), Department of Mathematics, Union College, Schenectady, NY 12308. *Models for Taylor Polynomials of Functors.*

Let C and D be simplicial model categories. Let $f : A \to B$ be a fixed morphism in C and C_f be the category whose objects are pairs of morphisms $A \to X \to B$ in C that factor f. Using a generalization of Eilenberg and Mac Lane's notion of cross effect functors (originally defined for functors of abelian categories) to functors from C_f to D, we produce a tower of functors, $\cdots \to \Gamma_n^f F \to \Gamma_{n-1}^f F \to \cdots \to \Gamma_0^f F$, that acts like a Taylor series for the functor F. We compare this to the Taylor tower for F produced by Tom Goodwillie's calculus of homotopy functors, and establish conditions under which they agree. We use these constructions to show that two potential methods for defining an analogue of de Rham cohomology for E_∞-algebras are equivalent. This is joint work with Kristine Bauer, Rosona Eldred, and Randy McCarthy. (Received June 28, 2011)

57 ► Manifolds and cell complexes

1072-57-1 **Mladen Bestvina***, Department of Mathematics, University of Utah, 155 S 1400 E, Salt Lake City, UT 84112. *Topology and Geometry of $Out(F_n)$.*

The study of $Out(F_n)$, the group of outer automorphisms of the free group F_n of rank n, began by Nielsen in the 1920's. It reached the modern in the 1980's when Culler and Vogtmann introduced *Outer space*, a contractible space on which $Out(F_n)$ acts properly discontinuously. More recently, metric properties of Outer space have become a focus of study, giving simpler proofs of old results and opening doors to new. The talk will emphasize analogies with mapping class groups and Teichmüller theory. (Received June 5, 2011)

1072-57-14 **Timothy Perutz*** (perutz@math.utexas.edu). *The Fukaya category of the punctured torus.*

I report on joint work with Yanki Lekili which characterizes the Fukaya category of compact exact Lagrangians in the once punctured 2-torus. This category is generated by a certain two-object subcategory. We show that the "moduli space" of A-infinity structures on this subcategory is also the moduli space of Weierstrass curves (that is, irreducible, pointed curves with a non-zero holomorphic differential). Under this "mirror" correspondence, the trivial A-infinity structure is related to the cuspidal cubic curve; the A-infinity structure of the Fukaya category is related to a nodal cubic; and filling the puncture to smoothing the node. (Received May 11, 2011)

1072-57-55 **Alexander Dranishnikov*** (dranish@math.ufl.edu), Department of Mathematics, University of Florida, Gainesville, FL 32611-8105. *Essential manifolds and macroscopic dimension.*

The following definitions are due to Gromov.

An n-manifold M is called *rationally essential* if $im(f_*) \neq 0$ in $H_n(B\pi;\mathbb{Q})$ where $f : M \to B\pi$ is a map that classifies the universal covering of M.

A metric space X has the macroscopic dimension at most n, $\dim_{mc} X \leq n$ if there is a continuous map $g : X \to K^n$ to an n-dimensional simplicial complex and a number $b > 0$ such that $diam(g^{-1}(y)) < b$ for all $y \in K^n$.

We present a counterexample to the following conjecture of Gromov: *For every rationally essential n-manifold M the universal covering $\tilde{M}$ taken with the lifted metric should have the macroscopic dimension equal to n,* $\dim_{mc} \tilde{M} = n$. (Received June 14, 2011)

1072-57-60 **Paul Kirk***, Mathematics Department, Bloomington, IN 47405, and **Scott Baldridge**, IN. *Coisotropic Luttinger surgery.*

We introduce a surgery operation on symplectic manifolds called coisotropic Luttinger surgery, which generalizes Luttinger surgery on Lagrangian tori in symplectic 4-manifolds. We use it to produce infinitely many distinct symplectic non-Kahler 6-manifolds X with $c_1(X) = 0$ which are not of the form $M \times F$ for M a symplectic 4-manifold and F a closed surface. (Received June 15, 2011)

1072-57-63 **Rob Schneiderman*** (robert.schneiderman@lehman.cuny.edu), **Jim Conant** and **Peter Teichner**. *Higher-order intersections in low-dimensional topology.*

The failure of the Whitney move in dimension 4 can be measured by constructing higher-order intersection invariants of *Whitney towers* built from iterated Whitney disks on immersed surfaces in 4–manifolds. For Whitney towers on immersed disks in the 4–ball, some of these invariants can be identified with previously known link invariants like Milnor, Sato-Levine and Arf invariants. This approach also leads to the definition of higher-order Sato-Levine and Arf invariants which detect the obstructions to framing a *twisted* Whitney tower, and appear to be new invariants. Recent joint work with Jim Conant and Peter Teichner has shown that, together with Milnor invariants, these higher-order invariants classify the existence of (twisted) Whitney towers of increasing order in the 4–ball. (Received June 15, 2011)

1072-57-88 **Matthew E Hedden*** (mhedden@math.msu.edu), Wells Hall, East Lansing, MI 48824, and **Olga Plamenevskaya** (olga@math.sunysb.edu), Stony Brook, NY 11794. *Contact structures, rational open books, and Dehn surgery.*

I'll talk about rational open book decompositions and their contact invariants, and then use these to prove existence results for tight contact structures on certain manifolds obtained by Dehn surgery along the binding of traditional open books. I'll also discuss how this circle of ideas may be useful to the question of which knots in the 3-sphere admit lens space surgeries. (Received June 21, 2011)

1072-57-94 **Ian Hambleton***, Department of Mathematics & Statistics, McMaster University, Hamilton, ON L8S 4K1, Canada. *Gauge theory and smooth group actions on 4-manifolds.* Preliminary report.

We will discuss an equivariant version of the Yang-Mills moduli spaces of ASD connections over a smooth 4-manifold, and previous applications of these moduli spaces to study smooth finite group actions on 4-manifolds (joint with Ronnie Lee). Work in progress concerns two problems (i) finding a bound on the orders of cyclic groups which can act smoothly on a K3 surface, and (ii) showing that a smooth odd order cyclic group action on $S^2 \times S^2$ has standard rotation numbers. (Received June 22, 2011)

1072-57-106 **Peter Linnell**, **Boris Okun*** (okun@uwm.edu) and **Thomas Schick**. *The strong Atiyah Conjecture for RA Artin and Coxeter groups.*

The Strong Atiyah Conjecture predicts possible denominators for the L^2-Betti numbers for groups with torsion. I will explain some of the ingredients of its proof for RA Artin and Coxeter groups. (Received June 23, 2011)

1072-57-107 **Jonathan Michael Bloom*** (jbloom@math.mit.edu), **Tomasz Mrowka** (mrowka@math.mit.edu) and **Peter Ozsvath** (petero@math.mit.edu). *A Künneth formula in monopole Floer homology.*

We extend the TQFT structure of monopole Floer homology to cobordisms with multiple ends, equipped with families of metrics. Combined with the surgery exact triangle, we establish a Künneth formula for monopole

Floer homology under connected sums. This application is joint work with Tomasz Mrowka and Peter Ozsváth. (Received June 23, 2011)

1072-57-108 **Yi-Jen Lee*** (yjlee@math.purdue.edu), **Taubes** and **Kutluthan**. *The sutured monopole Floer homology of M(1).*

I will describe certain variants of Kronheimer-Mrowka's definition of sutured monopole Floer homology. In particular, the relation between the monopole Floer homologies of a closed 3-manifold M and its corresponding sutured manifold M(1) plays a part in proving the equivalence between monopole Floer homology and Heegaard Floer homology of closed 3-manifolds. (Received June 23, 2011)

1072-57-115 **Ross Geoghegan***, ross@math.binghamton.edu. *$\mathbb{Z}G$-modules over $CAT(0)$ spaces.* Preliminary report.

Let G be a group acting by isometries on a proper CAT(0) space M and let A be a finitely generated $\mathbb{Z}G$-module. I will describe a theory of horospherical limit points of A in the boundary of M which Robert Bieri and I have been developing. In this short talk I'll indicate: (1) how the resulting geometry throws light on when A is finitely generated over $\mathbb{Z}K$ where K is an appropriate subgroup of G; and (2) how the whole theory extends to the non-positively curved world some of the ingredients of "tropical geometry", specifically the so-called "Gröbner fan". (Received June 23, 2011)

1072-57-128 **Ekholm**, **Etnyre**, **Ng** and **Sullivan*** (sullivan@math.umass.edu). *Transverse knot contact homology.*

I may discuss a filtration of the holomorphic curves used in knot contact homology which gives a non-trivial invariant for transverse knots in standard contact 3-space. Possibly some separate discussion on open string topology. (Received June 24, 2011)

1072-57-129 **J. Elisenda Grigsby*** (grigsbyj@bc.edu), 301 Carney Hall, Chestnut Hill, MA 02467, and **Denis Auroux** and **Stephan M. Wehrli**. *On Khovanov-Seidel quiver algebras and bordered Floer homology.*

The low-dimensional topology community has been energized in recent years by the introduction of a wealth of so-called "categorified" invariants. One obtains such invariants from two apparently unrelated points of view: 1) algebraically, via the higher representation theory of quantum groups, and 2) geometrically, via symplectic geometry and gauge theory. Although the invariants themselves share a number of formal properties, finding explicit connections between the two viewpoints has proven challenging.

In this talk, I will discuss a relationship between Khovanov-type (algebraic) and Heegaard-Floer-type (geometric) invariants of braids. Specifically, I will describe how the bordered Floer bimodule associated to the double-branched cover of a braid is related to a similar bimodule arising in work of Khovanov and Seidel. (Received June 24, 2011)

1072-57-142 **Jason F McGibbon*** (mcgibbon@math.umass.edu). *Combinatorial knot contact homology and 1-parameter families of knots.*

Knot contact homology is a combinatorial invariant of smooth knots in $\mathbb{R}^3$ arising from symplectic field theory. This invariant admits an action of the fundamental group of the space of knots, of which nontrivial examples are know. I will also discuss work towards a topological interpretation of the invariant. (Received June 26, 2011)

1072-57-181 **Selman Akbulut*** (akbulut@math.msu.edu), MSU, Dept of Mathematics, E. Lansing, MI 48824. *Double knot surgeries to S^4 and $S^2 \times S^2$.*

It is known that S^4 is a union of two fishtails, and $S^2 \times S^2$ is a union of two cusps (glued along their boundaries). Here we prove that for any choice of knots $K, L \subset S^3$ performing knot surgery operations $S^4 \rightsquigarrow S^4_{K,L}$ and $S^2 \times S^2 \rightsquigarrow (S^2 \times S^2)_{K,L}$ along both of these fishtails and cusps, respectively, do not change the diffeomorphism type of these manifolds. A corollary of this is that the fishtail (an immersed S^2 with one self intersection) can exotically knot in S^4 infinitely many ways. We prove these results by giving a general sufficiency criterion when a knot surgery operation $X \rightsquigarrow X_K$ doesn't change the smooth structure of the underlying manifold X. Another application of this technique is that all "Scharlemann manifolds" $M(K)$ for all knots K are standard (previously this was only proven for the trefoil knot by S. Akbulut in Ann of Math, 149 (1999), 497-510. Recall $M(K) \simeq S^1 \times S^3 \# (S^2 \times S^2)$ is obtained by surgering the meridianal circle $C \subset S^1 \times S^3_K$, where S^3_K be the 3-manifold obtained from S^3 by ± 1 surgery to K). (Received June 27, 2011)

1072-57-186 **Nathan S Sunukjian*** (nsunukjian@math.sunysb.edu). *Generalized surgeries on 4-manifolds and surface concordance.* Preliminary report.

Exotic smooth structures on 4-manifolds are typically constructed through one of the following techniques: knot surgery, log transform, rational blowdown, and Gluck twist. These are all surgeries that depend on finding surfaces in the manifold. This talk will discuss a generalization of these surgeries, the obstacles to using generalized surgeries to construct exotic manifolds, and, time permitting, discuss the role played by surface concordance. (Received June 27, 2011)

1072-57-188 **Patricia Cahn*** (patricia.cahn@dartmouth.edu), 6188 Kemeny Hall, Dartmouth College, Hanover, NH 03755, and **Vladimir Chernov**. *Algebras Counting Minimal Intersection and Self-Intersection Numbers of Loops on a Surface.*

It is natural to ask how to compute the minimum number of intersection points $m(\alpha, \beta)$ of loops in two given free homotopy classes α and β, and the minimum number of self-intersection points $m(\alpha)$ of a loop in a given class α. We show that for $\alpha \neq \beta$ the number of terms in the Andersen-Mattes-Reshetikhin Poisson bracket of α and β is equal to $m(\alpha, \beta)$. Chas found examples showing that a similar statement does not, in general, hold for the Goldman Lie bracket of α and β. The proof in the case where the given classes do not contain different powers of the same loop first appeared in work of the second author. To prove the result for any classes $\alpha \neq \beta$, we had to use techniques developed by the first author, who proved that if one generalizes the Turaev cobracket in the spirit of the Andersen-Mattes-Reshetikhin algebra, the number of terms in the resulting operation $\mu(\alpha)$ gives a formula for $m(\alpha)$, and furthermore, $\mu(\alpha) = 0$ if and only if α is a power of a simple class. Again, Chas showed that similar statements do not hold for the Turaev cobracket. (Received June 27, 2011)

1072-57-189 **Lawrence Roberts*** (lproberts@as.ua.edu). *On totally twisted Khovanov homology.*

We will describe a totally twisted reduced Khovanov complex for a link in the three sphere that is similar in spirit to the totally twisted Heegaard-Floer complex and the model of knot Floer homology recently described by Baldwin and Levine. Over an appropriate coefficient ring, the twisted complex admits a spanning tree model with an explicit differential whose homology is a link invariant. No such explicit model has been found for the original Khovanov complex. (Received June 27, 2011)

1072-57-197 **Wojciech Dorabiala*** (wud2@psu.edu), 3000 Ivyside Park, Altoona, PA 16601, and **Bernard Badzioch**. *Detecting non-trivial elements of $\pi_i(Diff(M \times S^m))$.* Preliminary report.

I will give new examples of elements of infinite order in the homotopy groups of $Diff(M \times S^m)$ detected by the higher Reidemeister torsion. (Received June 27, 2011)

1072-57-198 **Jennifer Hom*** (hom@math.columbia.edu). *Satellites and the knot concordance group.* Preliminary report.

If two knots are concordant, then their satellites are concordant as well. This fact can be used to define "new" concordance invariants, by composing the satellite operation with any previously defined concordance invariant. We will focus on the Ozsváth-Szabó τ invariant, and determine necessary and sufficient conditions for this new family of invariants to agree on a pair of knots. This is closely related to the concordance invariant ε. (Received June 27, 2011)

1072-57-200 **Matthew Hedden** (mhedden@math.msu.edu), Department of Mathematics, Michigan State University, East Lansing, MI 48824, and **Adam Simon Levine*** (levinea@brandeis.edu), Department of Mathematics, Brandeis University, Waltham, MA 02453. *Splicing Knot Complements and Bordered Heegaard Floer Homology.*

Let $K_1 \subset Y_1$ and $K_2 \subset Y_2$ be knots in homology three-spheres, and let $Y(K_1, K_2)$ be the homology three-sphere obtained by gluing together the complements of K_1 and K_2 via a map that takes meridian to 0-framed longitude and vice versa. We show using bordered Heegaard Floer homology that if K_1 and K_2 are both nontrivial knots, the Heegaard Floer homology group $\widehat{HF}(Y(K_1, K_2))$ has rank greater than 1. (Another proof of this fact is due to Eftekhary.) Thus, a three-manifold Y with $\operatorname{rank} \widehat{HF}(Y) = 1$ cannot contain an incompressible torus. (Received June 28, 2011)

1072-57-207 **David T Gay*** (d.gay@euclidlab.org) and **Robion Kirby**, Select One. *Morse 2-functions on 4-manifolds.*

A Morse 2-function is a generic smooth map to a smooth 2-manifold, with a 1-dimensional singular locus and a short list of local models, as an obvious generalization of a usual Morse function. I will discuss existence and uniqueness results for Morse 2-functions on 4-manifolds and focus on the extent to which these results can be

"combinatorialized", in analogy with the combinatorialization of Morse and Cerf theory to handle decompositions and handle moves. (Received June 28, 2011)

1072-57-233 **R. Inanc Baykur***, baykur@brandeis.edu. *Sections of surface bundles and Lefschetz fibrations.* Preliminary report.

We will discuss the possible self-intersection numbers for sections of surface bundles & Lefschetz fibrations over surfaces, and the (un)boundedness of the number of critical points of a Lefschetz fibration with maximally self-intersecting sections, for fixed fiber and base genera. We will also calculate the stable commutator length of certain elements in the mapping class groups of surfaces with boundary, yielding a stabilization result drastically different than in the case of closed surfaces. (Received June 28, 2011)

1072-57-251 **Allison L Gilmore*** (gilmore@math.columbia.edu), NY. *Knot Floer homology and Soergel bimodules.*

Abstract: We offer a construction of knot Floer homology modeled on the algebraic structure of HOMFLY-PT homology, as defined in Khovanov's "Triply-graded link homology and Hochschild homology of Soergel Bimodules." First, we enlarge the category of Soergel bimodules to obtain a categorification of $H(b,q)\otimes\mathbb{Z}[\ell,\ell^{-1}]$, where $H(b,q)$ is the Hecke algebra. We describe an action of $\mathrm{Br}_b\oplus\mathbb{Z}\langle\lambda\rangle$ on this category, where Br_b is the braid group on b strands. Then we introduce an operation $\mathcal{Q}$ that we claim recovers knot Floer homology of a braid's closure when applied to the generalized Soergel bimodule associated to the braid. We prove a weaker statement, outline the proof, and suggest how the same techniques could be used to prove the full result. (Received June 29, 2011)

1072-57-263 **Steven C Ferry*** (sferry@math.rutgers.edu), Dept of Mathematics, Rutgers University, 110 Frelinghuysen Rd, Piscataway, NJ 08854. *Characteristic classes for singular spaces.*

We will describe a construction of characteristic classes for some very singular spaces. (Received June 29, 2011)

58 ► Global analysis, analysis on manifolds

1072-58-40 **Tian-Jun Li*** (lixxx248@umn.edu), School of Mathematics, University of Minnesota, Mpls, MN 55455. *Symplectic Calabi-Yau surfaces.*

Symplectic 4-manifolds with negative Kodaira dimension have been classified up to symplectomorphisms. In the next case, Kodaira dimension zero, there is a speculation that such a manifold is diffeomorphic to K3, Enriques surface or a torus bundle over torus. I will discuss what is known towards this conjectured smooth classification (part of this talk is based on joint works with Yi Ni, Chung-I Ho). (Received June 09, 2011)

1072-58-90 **Katrin Wehrheim*** (wehrheim@mit.edu), 77 Mass Ave, Cambridge, MA 02139. *Virtual fundamental cycle and reparametrizations.* Preliminary report.

I will give a report on work in progress with Dusa McDuff on trying to clarify analytic subtleties involving reparametrizations of maps in the construction of a virtual fundamental cycle or Kuranishi structure. (Received June 21, 2011)

1072-58-110 **Sushmita Venugopalan*** (sushvenu@math.rutgers.edu) and **Chris Woodward**. *Yang-Mills-type heat equation on gauged holomorpic maps.* Preliminary report.

Let G be a compact Lie group and, $P\to\Sigma$ be a principal G-bundle on the Riemann surface Σ. Let X be a compact Kahler Hamiltonian-G-manifold with moment map Φ. A gauged holomorphic map is a pair (A,u) where A is a connection on P and u is a holomorphic section of the fiber-bundle $(P\times X)/G$. On the space of these holomorphic maps, the action of the gauge group has moment map $(A,u)\mapsto *F_A+u^*\Phi$.

In this work with Chris Woodward, we study the gradient flow lines of the functional $(A,u)\mapsto\|*F_A+u^*\Phi\|^2_{L^2}$. For compact Σ, possibly with boundary, we prove long time existence of flow. The flow lines converge to critical points of the functional.

This gradient flow preserves complex gauge orbits. And, the zero level set of the functional are symplectic vortices. So, an application of this is to prove a version of Mundet's Hitchin-Kobayashi corresponce on $\mathbb{C}$ - if (A,u) is a gauged holomorphic map on $\mathbb{C}$ with $\|*F_A+u^*\Phi\|_{L^2}<\infty$, satisfying some stability conditions, then the closure of its complex gauge orbit contains a symplectic vortex. This could lead to a generalization of the classification result of Jaffe-Taubes. (Received June 23, 2011)

1072-58-152 **Richard H Bamler*** (rbamler@math.princeton.edu), 3 Lawrence Dr, Apt 203, Princeton, NJ 08540. *Stability of symmetric spaces under Ricci flow.*

We establish stability results for symmetric spaces of noncompact type under Ricci flow, i.e. we will show that any small perturbation of the symmetric metric is flown back to the original metric under an appropriately rescaled Ricci flow. It will be important for us which smallness assumptions we have to impose on the initial perturbation. We will find that as long as the symmetric space does not contain any hyperbolic or complex hyperbolic factor, we don't have to assume any decay on the perturbation. Furthermore, in the hyperbolic and complex hyperbolic case, we show stability under a very weak assumption on the initial perturbation. This will generalize a result obtained by Schulze, Schnürer and Simon in the hyperbolic case. The proofs of those results make use of an improved L^1-decay estimate for the heat kernel in vector bundles as well as elementary geometry of negatively curved spaces. (Received June 26, 2011)

1072-58-234 **Naotaka Kajino*** (nkajino@math.uni-bielefeld.de), Department of Mathematics, University of Bielefeld, Postfach 10 01 31, 33501 Bielefeld, Germany. *Weyl's Laplacian eigenvalue asymptotics for the measurable Riemannian structure on the Sierpinski gasket.*

On the Sierpinski gasket K, Kigami [Math. Ann. 340 (2008)] has introduced the notion of the measurable Riemannian structure, with which the gradient vector fields of functions, the Riemannian volume measure μ and the geodesic metric ρ are naturally associated. Kigami has also proved in the same paper the two-sided Gaussian bound for the corresponding heat kernel, and I have further shown several detailed heat kernel asymptotics, such as Varadhan's asymptotic relation, in a recent paper [Potential Anal., in press].

In the talk, the Weyl's Laplacian eigenvalue asymptotics is presented for this case. Specifically, let d be the Hausdorff dimension of K and $\mathcal{H}^d$ the d-dimensional Hausdorff measure on K, both with respect to ρ. Then for some $c_N > 0$ and for any $U \subset K$ non-empty open with $\mathcal{H}^d(\partial U) = 0$,

$$\lim_{\lambda \to \infty} \frac{N_U(\lambda)}{\lambda^{d/2}} = c_N \mathcal{H}^d(U),$$

where $N_U(\lambda)$ is the number of the eigenvalues, less than or equal to λ, of the Dirichlet Laplacian on U. Moreover, we will also see that $\mathcal{H}^d$ is Ahlfors d-regular with respect to ρ but that it is singular to the Riemannian volume measure μ. (Received June 28, 2011)

1072-58-245 **Tomasz Mrowka**, **Daniel Ruberman** and **Nikolai Saveliev*** (saveliev@math.miami.edu). *An index theorem for end-periodic operators.*

We extend the Atiyah, Patodi, and Singer index theorem for first order differential operators from the context of manifolds with cylindrical ends to manifolds with periodic ends. This theorem provides a natural complement to Taubes' Fredholm theory for general end-periodic operators. Our index theorem is expressed in terms of a new periodic eta-invariant that equals the Atiyah-Patodi-Singer eta-invariant in the cylindrical setting. (Received June 29, 2011)

60 ► Probability theory and stochastic processes

1072-60-44 **Jun Kigami***, Graduate School of Informatics, Kyoto University, Yoshida-Honmachi, Sakyo, Kyoto, Kyoto 606-8501, Japan. *Dirichlet forms on a noncompact Cantor set and random walks on its defining tree.*

First we will construct a class of Dirichlet forms on a noncompact Cantor set, which is a generalization of p-adic numbers, from prescribed sets of eigenvalues and measures. At the same time, we have concrete expressions of the jump kernel and the transition density. Assuming the volume doubling condition, we constract an intrinsic metric under which estimates of transition density and jump kernel are obtained. Secondly transient random walks on the difining tree of the noncompact Cantor set are shown to induce a subclass of Dirichlet forms discussed in the first part on the noncompact Cantor set as traces. (Received June 10, 2011)

1072-60-102 **Benjamin Steinhurst*** (steinhurst@math.cornell.edu). *Brownian motion on non-self-similar Sierpinski carpets.* Preliminary report.

This class non-self-similar carpets were by MacKey, Tyson, and Wildrick to serve show that metric measure spaces which are embedable in Euclidean space but which have no interior can support Poincare inequalities. A consequence of the Poincare inequality is an almost everywhere cotangent bundle with associated Dirichlet form and Brownian motion. Their work relies on assuming that the chosen construction produces a fractal with positive 2−Lebesgue measure. In this talk we will address the construction of a Brownian motion in the case where the 2−Lebesgue measure is zero. (Received June 22, 2011)

1072-60-161 **Ka-Sing Lau*** (kslau@math.cuhk.edu.hk), Department of Mathematics, The Chinese University of Hong Kong, Hong Kong, Hong Kong, and **Ting-Kam Wong** (tkwong@math.cuhk.edu.hk). *Random walk and induced Dirichlet form on self-similar sets.*

We consider a class of reversible Markov chains on the symbolic space of a self-similar set K. We identify the Martin boundary of the chain with K through some hyperbolic graph structure on the symbolic space. We also show that the graph energy induces a Dirichlet form on K that has a jump kernel. (Received June 27, 2011)

1072-60-220 **Michael Hinz*** (Michael.Hinz.1@uni-jena.de). 1-*forms on fractals and harmonic spaces.*

The talk discusses substitutes for differential 1-forms on possibly non-smooth spaces. If a suitable energy functional is given, 1-forms may be defined using a certain tensor space endowed with a norm based on the energy measure. The construction is a variant of the one introduced by Cipriani and Sauvageot and studied further by Ionescu/Rogers/Teplyaev and Cipriani/Guido/Isola/Sauvageot. It is consistent with the classical notions and has nice algebraic and continuity properties. In connection with open covers it reflects some topological features of the base space. The present results apply also to some fractals which are not necessarily finitely ramified, such as Sierpinski carpets. (Received June 28, 2011)

1072-60-242 **Eric Y Akkermans*** (eric@physics.technion.ac.il), Physics Department, Technion Israel Institute, 32000 Haifa, Israel. *Statistical mechanics and quantum field theory on fractal structures. Application to quantum optics and superfluidity.* Preliminary report.

Fractals define a new and interesting realm for a discussion of basic phenomena in QED and quantum optics and their implementation. This interest results from specific properties of fractals, e.g., their dilatation symmetry as opposed to the translation symmetry of Euclidean space and the corresponding absence of Fourier mode decomposition. Moreover, the existence of a set of distinct (usually non integer) dimensions characterizing the physical properties (spatial or spectral) of fractals make them a useful testing ground for dimensionality dependent physical problems.

We shall start by noting that the absence of Fourier transform on a fractal implies necessarily different notions of volume in direct and reciprocal spaces and thus the need to modify the Heisenberg uncertainty principle. Implications for field quantization and the definition of the notion of photon on a fractal will be further addressed.

These ideas will find interesting applications in quantum optics of fractal cavities. We shall then turn to the case of massive bosons and discuss the nature of Bose-Einstein condensation and the onset of superfluidity in fractal structures. (Received June 29, 2011)

68 ► Computer science

1072-68-68 **Nitesh Saxena*** (nsaxena@poly.edu). *Tree-based HB Protocols for Privacy-Preserving Authentication of RFID Tags.*

An RFID reader must authenticate its designated tags in order to prevent tag forgery and counterfeiting. At the same time, due to privacy requirements of many applications, a tag should remain anonymous and untraceable to an adversary during the authentication process. In this talk, we present an "HB-like" protocol for privacy-preserving authentication of RFID tags. Previous protocols for privacy-preserving authentication were based on PRF computations. Our protocol can instead be used on low-cost tags that may be incapable of computing traditional PRFs. Moreover, since the underlying computations in HB protocols are very efficient, our protocol also reduces reader-side load compared to PRF-based protocols.

We suggest a tree-based approach that replaces the PRF-based authentication from prior work with a procedure such as HB+ or HB#. We optimize the tree-traversal stage through usage of a "light version" of the underlying protocol and shared random challenges across all levels of the tree. This provides significant reduction of the communication resources, resulting in a privacy-preserving protocol almost as efficient as the underlying HB+ or HB#. (Received June 16, 2011)

1072-68-69 **Dexter C Kozen*** (kozen@cs.cornell.edu), Computer Science Dept, 5143 Upson Hall, Cornell University, Ithaca, NY 14853-7501. *Kleene Algebra with Tests and the Static Analysis of Programs.*

We propose a general framework for the static analysis of programs based on Kleene algebra with tests (KAT). We show how KAT can be used to statically verify compliance with safety policies specified by security automata. We prove soundness and completeness over relational interpretations. We illustrate the method on an example involving the correctness of a device driver. (Received June 16, 2011)

1072-68-155 **Chi Sing Chum** and **Xiaowen Zhang*** (xiaowen.zhang@csi.cuny.edu), 2800 Victory Blvd, 1N-215, Staten Island, NY 10314. *Improving Latin square based secret sharing schemes.*

Because there exists a huge number of different Latin squares for a relatively large order greater than or equal 10, Latin square has been used to represent a secret in secret sharing schemes since 90s. However the schemes based on Latin squares proposed in the literature are subject to various limitations. Using critical sets for implementation improves the efficiency and flexibility, but the difficulties on finding critical sets make such implementation impractical. In order to overcome these limitations, we propose to apply cryptographic hash functions and herding hashes technique into Latin square based schemes. Our schemes can realize any access structure. They are perfect, ideal, efficient, and flexible. They can be easily set up as proactive or verifiable if required. We also outline a proposal for the implementation. (Received June 26, 2011)

1072-68-201 **Maggie Habeeb***, Mathematics Department, 365 Fifth Avenue, New York, NY 10016, and **Delaram Kahrobaei**. *A New Secret Sharing Scheme using Non-abelian Groups.*

Threshold secret sharing schemes are a method to distribute a secret among n persons in such a way that any t, where $0 < t \leq n$, of the participants can recover the secret, but no $t-1$ participants can. In this talk, we propose two new secret sharing schemes using non-abelian groups and the word problem. One scheme is the special case where all the participants must get together to recover the secret; that is, $t = n$. The second scheme we propose is a (t, n)-threshold scheme that is a hybrid of Shamir's scheme and the group theoretic scheme. (Received June 28, 2011)

1072-68-232 **Ali Bagherzandi** and **Stanislaw Jarecki*** (stasio@ics.uci.edu), CA, and **Nitesh Saxena** and **Yanbin Lu**. *Password-Protected Secret Sharing.*

We revisit the problem of protecting user's private data against corruption of user's storage. To this aim we introduce Password-Protected Secret-Sharing (PPSS), which allows for secret-sharing user's data among n trustees in such a way that (1) the user can reconstruct the data by entering the correct password into a reconstruction protocol involving at least $t + 1$ honest trustees, and (2) the data remains secret even if the adversary corrupts t trustees, with the level of protection expected of password-authentication, i.e. the probability of leaking the secret is at most q/D where q is the number of reconstruction instances and D is the size of the dictionary from which user's password was chosen. We show an efficient PPSS protocol secure under the DDH assumption using three messages between the user and each server, each with constant bandwidth. As side benefit we obtain a Threshold Password Authenticated Key Exchange (T-PAKE) protocol with lower round, communication, and server computation complexities than existing T-PAKE's. (Received June 28, 2011)

76 ► Fluid mechanics

1072-76-20 **Md. Khairul Bashar** (bd_kairul@yahoo.com), Senior officer, Sonali Bank, Cox's Bazar, Chittagong , Bangladesh, and **Rasel Biswas*** (rb3247@mun.ca), Department of Mathematics and Statistics, Memorial University, St. John's, NL A1C5S7, Canada. *Effects of pressure stress work and viscous dissipation in mixed convection flow along a vertical flat plate in presence of heat generation.*

The effects of viscous dissipation and pressure work in mixed convection flow along a vertical flat plate in presence of heat generation have been investigated. The results is obtained by transforming the governing system of boundary layer equations into a system of non-dimensional equations and by applying the implicit finite difference method along with Newton's linearization approximation. Numerical results for different values of the heat generation parameter, viscous dissipation parameter, pressure stress work parameter with Prandtl number 0.72 which corresponds to air at 250°K have been obtained. The velocity profiles, temperature distributions, skin friction coefficient, and the rate of heat transfer have been presented graphically for the effects of the abovementioned parameters in presence of heat generation. (Received May 20, 2011)

1072-76-79 **Volker W Elling*** (velling@umich.edu), University of Michigan, East Hall, 530 Church St, Ann Arbor, MI 48105. *Non-existence of strong regular reflections in self-similar potential flow.*

We consider shock reflection which has a well-known local non-uniqueness: the reflected shock can be either of two choices, called weak and strong. The weak kind may have flow of mixed type on the downstream side where the strong type is always elliptic.

We consider cases where existence of a global solution with weak reflected shock has been proven, for compressible potential flow. If there was a global strong-shock solution as well, then potential flow would be ill-posed.

However, we prove non-existence of strong-shock analogues in a natural class of candidates. (Received June 20, 2011)

1072-76-123 **Pam Cook*** (cook@math.udel.edu), Department of Math Sciences, University of Delaware, Newark, DE 19716, and **Lin Zhou**, **Michael Cromer** and **Gareth McKinley**. *Models and flows of complex (wormlike micellar) fluids.*

Highly entangled microstructural systems such as wormlike micellar (surfactant) fluids can exhibit spatially inhomogeneous shear-banding structures under simple deformations. Rheological equations of state capable of describing these fluids include the VCM model, a model which specifically incorporates the rate-dependent breakage and reforming of these wormy micelles. The resulting coupled system of nonlinear partial differential equations, constitutive equations together with conservation of mass and momentum, describes the number density and stresses of each of the micellar species in addition to other stress-relaxation mechanisms. In shear flow the model predicts the localized shear-bands where the macroscopic field varies rapidly and the fluid microstructure is highly aligned. The use of numerics and asymptotics to interrogate these models in transient and oscillatory shear, and pressure-driven flow in microfuidic devices will be described. Of particular emphasis will be the predictions of the model including boundary layers, shear layers, and with and without inertial effects. (Received June 24, 2011)

1072-76-126 **Antonio Mastroberardino*** (axm62@psu.edu), 4205 College Drive, Erie, PA 16563. *Annular axisymmetric stagnation flow on a moving cylinder.*

In various industrial applications, fluid is injected from a fixed outer cylindrical casing onto an inner moving cylindrical rod. This scenario is particularly important in pressure-lubricated bearings. Using a similarity transformation, the Navier-Stokes equations that govern this type of flow can be reduced to a 4th order nonlinear boundary value problem. In this presentation, I will provide analytical solutions to this ordinary differential equation using the homotopy analysis method and compare these results with numerical solutions. (Received June 24, 2011)

81 ► Quantum theory

1072-81-80 **Gerald V. Dunne*** (dunne@phys.uconn.edu), Department of Physics, University of Connecticut, Storrs, CT 06269-3046. *Thermodynamics on Fractals.*

Quantum particles in thermal equilibrium probe the geometry in which they are confined. This idea can be used to address certain questions relating to fractals and a consistent thermodynamics may be defined based on the density of states extracted from the fractal zeta function or heat kernel trace. (Received June 20, 2011)

1072-81-151 **Anton Zeitlin*** (anton.zeitlin@yale.edu), 10 Hillhouse Ave, 4th floor, Dept. of Mathematics, New Haven, 06511. *Homotopy Relations for Topological VOA.*

We consider a parameter-dependent version of the homotopy associative part of the Lian-Zuckerman homotopy algebra and provide an interpretation of the multilinear operations of this algebra in terms of integrals over certain polytopes. The key ingredient in the construction is the consideration of nonlocal vertex operators. We explicitly prove the pentagon relation up to homotopy and propose a construction of the higher operations. (Received June 26, 2011)

1072-81-178 **Ingo Runkel***, Fachbereich Mathematik, Univ. Hamburg, Bundesstr. 55, 20146 Hamburg, Germany. *Symplectic Fermions and Logarithmic CFT.*

Symplectic fermions are one of the earliest and best studied examples of a logarithmic conformal field theory. Logarithms appear in the singular behaviour of four-point conformal blocks with insertions taken from irreducible representations in the Ramond sector. Since symplectic fermions are a free field theory, many interesting quantities can be computed explicitly. I would like to present results for the braided monoidal structure on the category of representations, which are obtained form explicit knowledge of the three- and four-point conformal blocks. (Received June 27, 2011)

1072-81-237 **Matthew T Krauel*** (mkrauel@ucsc.edu). *Vertex operator algebra* 1*-point functions and Jacobi forms.*

I will discuss recent developments concerning Jacobi forms and a type of 1–point trace function associated with certain vertex operator algebras. In particular, I will focus on criteria in which homogeneous elements of weight k in a vertex operator algebra give rise to vector-valued weak Jacobi forms of weight k and index m. (Received June 28, 2011)

82 ► Statistical mechanics, structure of matter

1072-82-28 **Joe P. Chen*** (joe.p.chen@cornell.edu), Cornell University, Ithaca, NY 14853.
Statistical mechanics of Bose gas in Sierpinski carpets.

I will discuss the equilibrium thermodynamics of massless and massive bosons confined in generalized Sierpinski carpets (GSCs), a class of infinitely ramified fractals having non-integer dimensions. Based on the uniqueness of Brownian motion on GSCs, as well as the state-of-the-art estimate of the heat kernel trace, we can, for the first time, make concrete calculation of the spectral zeta function, which is then used to construct the grand canonical partition functions. For physical applications, I will describe blackbody radiation and Casimir effect in fractal waveguides, and show that Bose-Einstein condensation exists in the thermodynamic limit iff the Hamiltonian is transient, i.e., the spectral dimension exceeds 2. At the end I will offer a few experimental suggestions to test these results. (Received May 23, 2011)

1072-82-215 **Richard W Kenyon***, Mathematics Dept., 151 Thayer St, Providence, RI 02912.
Spectrum of the Laplacian on periodic and quasiperiodic planar graphs.

The spectrum of the discrete Laplacian on quasiperiodic planar graphs is studied via approximation by periodic graphs. For periodic graphs, there is a complete characterization of Laplacian spectra in terms of Harnack curves. These curves have well-controlled limits as the period increases. Some consequences for probability models on quasiperiodic planar graphs will be discussed. (Received June 28, 2011)

94 ► Information and communication, circuits

1072-94-104 **Vladimir Shpilrain*** (shpil@groups.sci.ccny.cuny.edu), Department of Mathematics, The City College of New York, New York, NY 10031. *Reflections on learning with errors.* Preliminary report.

Recovering a homomorphism between groups from several (preimage, image) pairs is a well studied problem. For some groups, it is known to be NP-hard, although this does not really help in assessing security of relevant cryptographic primitives. It gets more interesting when images are distorted by "small errors". Recovering a homomorphism gets much harder in this setting, which makes this problem potentially suitable for applications in cryptography since the problem may become NP-hard generically (or on average) for some instantiations. However, there are some auxiliary problems about platform groups, including the geodesic length problem, that one has to address first. (Received June 23, 2011)

1072-94-203 **Kenneth R. Matheis**, **Rainer Steinwandt*** (rsteinwa@fau.edu) and **Adriana Suárez Corona**. *Algebraic properties of a lightweight block cipher.*

The block cipher DESL is a *DES Lightweight extension* which has been proposed at FSE 2007 by Leander et al. The structure of this block cipher is basically identical to DES, but differing from the latter, in DESL all S-boxes are identical. This talk discusses the permutation group generated by the round functions of DESL and reports on experiments with an algebraic attack known as *Multiple Right Hand Sides* when being applied to full and reduced round versions of DESL. (Received June 28, 2011)

05 ► Combinatorics

1073-05-13 **Risto Atanasov**, **Mark Budden**, **Joseph DiNatale**, **Lindsay Erickson** and **Robert Fenney***, Department of Mathematics, University Hall 297, 11935 Abercorn Street, Savannah, GA 31419, and **Maxwell Hostetter**, **Joshua Lambert** and **Warren Shreve**. *Analysis Of Winning Strategies For Playing On Wheel Graphs.* Preliminary report.

Nim provides an example of an impartial game studied in combinatorial game theory. Nim involves two-players with positions defined by the number of weights on three or more poles. We define moves by removing the weights from a distinct pole with the winner taking the last weight. Fukuyama extended Nim to graph theory by playing a similar game on weighted graphs. In Nim on graphs, we begin by placing a position indicator piece on a vertex and players decrease the weight of an incident edge to a nonnegative number. A player loses when all incident edges have weight zero. We focus on winning strategies for Nim on graphs. In particular, we shall completely classify the winner for Nim on a wheel with n-spokes. (Received June 3, 2011)

1073-05-14 **Mark Budden**, **Nicole Calkins**, **William Nathan Hack** and **Joshua K. Lambert*** (joshua.lambert@armstrong.edu), Department of Mathematics, University Hall 297, 11935 Abercorn Street, Savannah, GA 31419, and **Kimberly Thompson**. *Enumerating Triangles in a Rational Residue Graph.*

In 1962, Horst Sachs introduced Paley graphs to the world of mathematics. Paley graphs tie together graph theory and number theory by letting the vertices of our graph be the elements of $\mathbb{F}_p$ for $p \equiv 1 \bmod 4$ and an edge occurs between two vertices a and b if $a - b$ is a quadratic residue in $\mathbb{F}_p$. Similar to Sachs' invention, the rational residue graph has vertices coming from elements of a field of prime order $p \equiv 1 \bmod 2^{t+1}$ and the edges are formed between vertices a and b when $a - b$ is a 2^tth residue. The properties of rational residues create symmetry in these graphs, which will provide us with a formula for the number of triangles in rational residue graphs. (Received June 3, 2011)

1073-05-15 **Joseph E. Bonin*** (jbonin@gwu.edu), Department of Mathematics, The George Washington University, Washington, DC 20052. *The excluded minors for lattice path matroids.*

Lattice path matroids are special transversal matroids that have a simple interpretation in terms of lattice paths. They have many attractive properties, many of which fail for arbitrary transversal matroids; for instance, the class of lattice path matroids is minor-closed and dual-closed; also, their Tutte polynomials can be computed in polynomial time. The first part of this talk will give a brief overview of lattice path matroids; the second will present the (infinitely many!) excluded minors for this class of matroids (that is, the minor-minimal obstructions to membership in the class) along with a sketch of the proof of this result. (Received June 5, 2011)

1073-05-16 **John T. Hird*** (jthird@ncsu.edu), Department of Mathematics, Box 8205, NC State University, Raleigh, NC 27695-8205. *Codes of partitions.*

The Bernstein operators are a special set of vertex operators that can generate the Schur functions. We generalize the combinatorial object codes of partitions to codes of compositions and show how this relationship can help us understand the action of the Bernstein operators on Schur functions. We also show the analogous results and combinatorial objects for Schur Q-functions. (Received June 6, 2011)

1073-05-22 **Francois Bergeron*** (bergeron.francois@uqam.ca), Math. Dept., UQAM, C.P. 8888, Succ Centre-Ville, Montreal, Quebec H3C3P8, Canada. *h-Positivity and Diagonal Coinvariant Spaces.*

We discuss the implications of positivity of coefficients for the expansion of the multigraded Hilbert series of diagonal coinvariant spaces in the h-basis (of complete homogeneous symmetric functions). This gives rise to several new combinatorial identities. (Received June 29, 2011)

1073-05-24 **Drago Bokal**, **Mojca Bracic**, **Eva Czabarka*** (czabarka@math.sc.edu) and **Laszlo A. Szekely**. *Graph orientation and lower bounds on crossing number.*

There are several lower bounds on the (ordinary) crossing number of a graph provided by the Euler formula and its variants involving the girth, the Leighton Lemma and other methods. Euler-type and Leighton-type bounds

are often better on a proper subgraph than on the entire graph. We examine how to find a best subgraph with respect to an Euler-type lower bound on crossing number. The problem of finding such a subgraph is equivalent to finding an orientation with a certain property in a multigraph. The solution is a slight extension of a result of Frank and Gyárfás on optimal graph orientations. (Received July 02, 2011)

1073-05-26 **Lincoln Lu** and **Laszlo A. Szekely*** (szekely@math.sc.edu). *Using the Lovász Local Lemma in graphical enumeration.* Preliminary report.

The lopsided version of the Lovász Local Lemma is based on negative dependency graphs instead of the usual dependency graphs. Two generic examples of negative dependency graphs that are not dependency graphs live in the space of maximal matchings of K_{2n} or $K_{n,m}$ endowed with the counting measure. For a partial matching M, the *canonical event* A_M is the set of all maximal matchings that extend M. We proved that for a family of canonical events, a negative dependency graph is defined by pairs of events A_M, $A_{M'}$, where $M \cup M'$ is not a (partial) matching.

Combining this result with the configuration model to create random graphs with a prescribed degree sequence, and adding to the Lovász Local Lemma *upper bounds* (just for the models considered above!) leads to proofs to a number of old and new results in asymptotic graph enumeration. (Received July 06, 2011)

1073-05-28 **Adriano M. Garsia*** (garsia@math.ucsd.edu), 4695 Mt Armet Dr, San Diego, CA 92117. *A new "dinv" statistic in the Theory of Parking Functions and Diagonal Harmonics.*

The decade old "shuffle conjecture" gives a Parking function interpretation to the Frobenius characteristic of Diagonal Harmonic polynomials. A recent more refined version by Haglund-Morse-Zabrocki states that the Hall scalar product of the homogeneous basis element h_μ with the Nabla operator acting upon a modified Hall-Littlewood polynomial indexed by a composition p enumerates, by $t^{area}q^{dinv}$, the family of Parking Functions whose supporting Dyck path hits the main diagonal according to p and whose diagonal word is a shuffle of type μ. Computer explorations show that when $\mu = (j, n)$, by replacing Nabla with the Macdonald eigen-operator Δ_{h_j} the composition p gives the position of the diagonal hits of the Dyck path supporting cars $j+1, j+2, \ldots, j+n$. The authors prove a recursion satisfied by the resulting polynomial and use it to construct a dinv-like statistic "ndinv" proving that this polynomial enumerates the latter family of Parking Functions by $t^{area}q^{ndinv}$. This is joint work of the presenter with A. Duane and M. Zabrocki. (Received July 08, 2011)

1073-05-30 **Ralph J. Faudree** and **Ronald J. Gould*** (rg@mathcs.emory.edu), Department of Math and CS, Atlanta, GA 30322, and **Michael S. Jacobson**. *More about cycles in generalized claw-free graphs.*

For $s \geq 3$, a graph is $K_{1,s}$-free if it does not contain an induced subgraph isomorphic to $K_{1,s}$. In this talk we will look at some recent results about disjoint cycles in $K_{1,s}$-free graphs, for $s \geq 3$. In particular, we show that if G is $K_{1,s}$-free of sufficiently large order $n = 3k$ with $\delta(G) \geq n/2 + c$ for some constant $c = c(s)$, then G contains k disjoint triangles. Analogous results with the complete graph K_3 replaced by a complete graph K_m for $m \geq 3$ are also shown. Using this work we also prove a $K_{1,s}$-free version of the Posa-Seymour conjecture. (Received July 11, 2011)

1073-05-32 **Angela S Hicks*** (ashicks@math.ucsd.edu), Department of Mathematics, University of California, San Diego (UCSD), 9500 Gilman Drive # 0112, La Jolla, CA 92093, and **Yeonkyung Kim** (yeonkyung@ucsd.edu), Department of Mathematics, University of California, San Diego (UCSD), 9500 Gilman Drive # 0112, La Jolla, CA 92037. *A New Parking Function Statistic.*

In this talk, we present a new "diagonal inversion" statistic on a subset of the parking functions. First defined recursively in a recent paper by Duane, Garsia, and Zabrocki, the statistic allows an interpretation of $\langle \Delta_{h_j} C_{p_1} \ldots C_{p_k} 1, e_n \rangle$ for $\{p_1, \cdots, p_k\}$ a composition of n, Δ_{h_j} a particular Macdonald eigenoperator, and C_{p_i} a modified Hall-Littlewood operator. In particular, this expression q-t counts by area and "new dinv" the set of parking functions with reading word a shuffle of $1, 2, \cdots, j$ (the small cars) and $j+1, \cdots, n$ (the big cars), where: the last car is a big car; the p_1^{th}, $p_1 + p_2{}^{\text{th}}$, ... , and $p_1 + \cdots + p_k{}^{\text{th}}$ big cars fall in the main diagonal; and the remaining big cars are *not* in the main diagonal. In particular, this gives a new combinatorial interpretation of $\langle \nabla e_n, h_j h_{n-j} \rangle$, an expression previously studied in the context of the Shuffle Conjecture. In this talk we present a non-recursive definition for the new dinv that more closely imitates the original diagonal inversion statistic as defined by Haiman. (Received July 13, 2011)

1073-05-34 **Jacob Fox** and **Po-Shen Loh*** (ploh@cmu.edu), Department of Mathematical Sciences, Carnegie Mellon University, Pittsburgh, PA 15213. *On a problem of Erdős and Rothschild on edges in triangles.*

Erdős and Rothschild asked to estimate the maximum number, denoted by $h(n, c)$, such that every n-vertex graph with at least cn^2 edges, each of which is contained in at least one triangle, must contain an edge that is in at least $h(n, c)$ triangles. In particular, Erdős asked in 1987 to determine whether for every $c > 0$ there is $\epsilon > 0$ such that $h(n, c) > n^\epsilon$ for all sufficiently large n. We prove that $h(n, c) = n^{O(1/\log\log n)}$ for every fixed $c < 1/4$. This gives a negative answer to the question of Erdős, and is best possible in terms of the range for c, as it is known that every n-vertex graph with more than $n^2/4$ edges contains an edge that is in at least $n/6$ triangles.

Joint work with Jacob Fox. (Received July 16, 2011)

1073-05-35 **Tai Há**, **Erik Stokes** and **Fabrizio Zanello*** (zanello@math.mit.edu), Department of Mathematics, MIT, Office 2-336, Cambridge, MA 02139. *Stanley's matroid h-vector conjecture in low rank.*

A much-studied conjecture of Richard Stanley's predicts that all matroid h-vectors are pure O-sequences. I will describe a possible new, and in a sense more abstract, approach to it. Its main object is to translate a substantial portion of the problem into one on the structural properties of pure O-sequences. This approach in part relies on the recent progress on pure O-sequences, and does not need to construct explicitly a pure monomial order ideal for each given matroid h-vector, as often done in the past.

Using the Interval Property for pure O-sequences of socle degree 3 (recently proved by M. Boij, J. Migliore, R. Miró-Roig, U. Nagel and myself as part of an upcoming AMS Memoir), I will outline a solution to Stanley's conjecture for matroids of rank at most 3. I will conclude with some possible suggestions for future research in this direction.

All the material I will discuss in this talk comes from a joint work with T. Há and E. Stokes (available on the arXiv as preprint 1006.0325, or upon request). (Received July 17, 2011)

1073-05-36 **Carolina Benedetti*** (caro.benedetti@gmail.com). *Supercharacter theory and symmetric functions.* Preliminary report.

In this talk we give a quick introduction to supercharacters and then we will present some results about the supercharacter theory for the group of unipotent upper triangular matrices over the finite field $\mathcal{F}_q$, denoted by $U_n(q)$. This SC theory of $U_n(q)$ realizes the Hopf algebra of symmetric functions in non commuting variables. These results are join work during an AIM workshop on Supercharacters and Combinatorial Hopf algebras.

Also, we give partial results from the combinatorial point of view on the supercharacter theory for the classical finite group of upper triangular matrices of type D. (Received July 17, 2011)

1073-05-39 **Matthias Lenz*** (lenz@math.tu-berlin.de), Technische Universität Berlin, MA 4-5, Strasse des 17. Juni 136, 10623 Berlin, Germany. *Zonotopal Algebra, Power Ideals, and Log-Concavity.*

Zonotopal algebra is the study of several classes of graded vector spaces of polynomials that can be assigned to a realization of a matroid. Those spaces can be described as inverse systems of power ideals. Their Hilbert series are matroid invariants.

In the first part of the talk, we introduce *hierarchical zonotopal power ideals*. This extends and unifies results by Ardila-Postnikov, Holtz-Ron, and Holtz-Ron-Xu.

In the second part, we explain the relationship between zonotopal algebra and various matroid/graph polynomials. In addition, we show that log-concavity of the coefficients of the characteristic polynomial (recently proved by Huh and Katz for realizable matroids) implies log-concavity of the f-vector of the independence complex of matroids. (Received July 27, 2011)

1073-05-40 **Felipe Rincon***, felipe@math.berkeley.edu. *Isotropical Linear Spaces and Valuated Delta-Matroids.*

The spinor variety is defined by the quadratic Wick relations, and its points parametrize n-dimensional isotropic subspaces of a 2n-dimensional vector space. We explain how this picture tropicalizes, and we present a combinatorial theory of tropical Wick vectors and tropical linear spaces that are tropically isotropic. In particular, we show how tropical Wick vectors can be characterized in terms of subdivisions of Delta-matroid polytopes. Most of these results generalize the theory of tropical linear spaces and valuated matroids to the class of Coxeter matroids of type D. (Received July 18, 2011)

1073-05-44 **Sami Assaf*** (sassaf@math.mit.edu), **Nantel Bergeron** and **Frank Sottile**. *A combinatorial rule for the product of a Schubert polynomial by a Schur function.*

A fundamental problem in the Schubert calculus of the flag manifold is to find a Littlewood–Richardson rule for the product of two Schubert polynomials. Using the theory of dual equivalence graphs, we give a combinatorial rule for the special case of multiplying a Schubert polynomial by a Schur function. (Received July 19, 2011)

1073-05-49 **Cristian Lenart*** (lenart@albany.edu), Department of Mathematics and Statistics, State University of New York at Albany, 1400 Washington Avenue, Albany, NY 12222, and **Anne Schilling** (anne@math.ucdavis.edu), Department of Mathematics, University of California at Davis, One Shields Avenue, Davis, CA 95616-8633. *From Macdonald polynomials to a charge statistic in classical Lie types.*

The charge is an intricate statistic on words, due to Lascoux and Schützenberger, which gives positive combinatorial formulas for the Kostka polynomials. These are the coefficients in the expansion of the (type A) Hall-Littlewood symmetric polynomials in terms of Schur polynomials. It has been a long-standing problem to generalize charge to all classical types. I will present a method to address this problem based on the recent Ram-Yip formula for Macdonald polynomials. Then I will present my work with Anne Schilling, proving that the type A and C charge coincides with the energy function on the corresponding affine crystals. The latter are colored directed graphs encoding representations of quantum affine algebras when the quantum parameter goes to zero, and the energy function defines a grading on them. (Received July 21, 2011)

1073-05-50 **Ryan R. Martin*** (rymartin@iastate.edu), 396 Carver Hall, Department of Mathematics, Iowa State University, Ames, IA 50011, and **Jason J. Smith**. *Induced saturation number.* Preliminary report.

A graph G is H-saturated if G fails to have H as a subgraph, but the addition of any edge to G creates at least one copy of H as a subgraph.

The saturation number $\mathrm{sat}(n; H)$ is the minimum size of an H-saturated graph on n vertices. In this talk, we define a version of saturation number suitable for induced subgraphs. This version is closely related to the notion of satisfiability of Boolean formulas.

We will provide bounds for this induced saturation number as well as establish the induced saturation number of some specific graphs. (Received July 22, 2011)

1073-05-51 **Jingfen Lan*** (a-za1107@163.com), 1907 Wheat St. Apt.B, Columbia, SC 29205, and **Linyuan Lu** (lu@math.sc.edu) and **Lingsheng Shi** (lshi@math.tsinghua.edu.cn). *Graphs with Diameter n-e Minimizing the Spectral Radius.*

For a fixed integer $e \geq 1$, let $G^{min}_{n,n-e}$ be a graph with minimal spectral radius among all connected graphs on n vertices with diameter $n-e$. For $e = 1, 2, 3, 4, 5$, $G^{min}_{n,n-e}$ were determined before. Then Cioabă-van Dam-Koolen-Lee conjectured for fixed $e \geq 6$ that $G^{min}_{n,n-e}$ is in the family $\P_{n,e} = \{P^{2,m_2,\ldots,m_{e-4},n-e-2}_{2,1,\ldots 1,2,n-e+1} \mid 2 < m_2 < \cdots < m_{e-4} < n-e-2\}$. We settle their conjecture positively here.

Let $T_{(k_1,k_2,\ldots,k_{e-4})} = P^{2,m_2,\ldots,m_{e-4},n-e-2}_{2,1,\ldots 1,2,n-e+1}$ with $k_i = m_{i+1} - m_i - 1$, for $1 \leq i \leq e-4$, here $m_1 = 2$ and $m_{e-3} = n-e-2$. Let $s = \frac{n-6}{e-4} - 2 = \frac{\sum_{i=1}^{e-4} k_i + 2}{e-4}$. For $e \geq 6$ and sufficiently large n, we proved that $G^{min}_{n,n-e}$ must be one of the trees $T_{(k_1,k_2,\ldots,k_{e-4})}$ with the parameters satisfying $\lfloor s \rfloor - 1 \leq k_j \leq \lfloor s \rfloor \leq k_i \leq \lceil s \rceil + 1$ and $0 \leq k_i - k_j \leq 2$ for $j = 1, e-4$ and $i = 2, \ldots, e-5$; $|k_i - k_j| \leq 1$ for $2 \leq i, j \leq e-5$. These results are best possible as shown by cases $e = 6, 7, 8$, where $G^{min}_{n,n-e}$ are completely determined. Moreover, if $n-6$ is divisible by $e-4$ and n is sufficiently large, then $G^{min}_{n,e} = T_{(s-1,s,s,\ldots,s,s-1)}$. (Received July 21, 2011)

1073-05-55 **Xing Peng*** (pengx@mailbox.sc.edu), Department of Mathematics, University of South Carolina, Columbia, SC 29208, and **Linyuan Lu** (lu@math.sc.edu), Department of Mathematics, University of South Carolina, Columbia, SC 29208. *A Fractional Analogue of Brooks' Theorem.*

Let Δ be the maximum degree of a connected graph G. Brooks' theorem states that the only connected graphs with chromatic number $\Delta+1$ are complete graphs and odd cycles. Here we proved a fractional version of Brooks' theorem: we classified all connected graphs G with the fractional chromatic number $\chi_f(G) \geq \Delta$. (Joint work with Linyuan Lu) (Received July 24, 2011)

1073-05-56 **Daniel W. Cranston*** (dcranston@vcu.edu) and **Gexin Yu**. *Linear Choosability of Sparse Graphs.*

A linear coloring is a proper coloring such that each pair of color classes induces a union of disjoint paths. We study the linear list chromatic number, denoted $\mathrm{lc}_\ell(G)$, of sparse graphs. The maximum average degree of a

graph G, denoted $mad(G)$, is the maximum of the average degrees of all subgraphs of G. It is clear that any graph G with maximum degree $\Delta(G)$ satisfies $\mathrm{lc}_\ell(G) \geq \lceil \Delta(G)/2 \rceil + 1$. In this paper, we prove the following results: (1) if $\mathrm{mad}(G) < 12/5$ and $\Delta(G) \geq 3$, then $\mathrm{lc}_\ell(G) = \lceil \Delta(G)/2 \rceil + 1$, and we give an infinite family of examples to show that this result is best possible; (2) if $\mathrm{mad}(G) < 3$ and $\Delta(G) \geq 9$, then $\mathrm{lc}_\ell(G) \leq \lceil \Delta(G)/2 \rceil + 2$, and we give an infinite family of examples to show that the bound on $\mathrm{mad}(G)$ cannot be increased in general; (3) if G is planar and has girth at least 5, then $\mathrm{lc}_\ell(G) \leq \lceil \Delta(G)/2 \rceil + 4$. (Received July 24, 2011)

1073-05-57 **David Howard** (howard@techunix.technion.ac.il) and **Clifford Smyth*** (cdsmyth@uncg.edu). *Revolutionaries and Spies.*

Revolutionaries and spies is a game, $RS(G, m, r, s)$, played on a graph G between two teams: one team consists of r revolutionaries, the other consists of s spies. To start, each revolutionary chooses a vertex as its position; more than one revolutionary may choose the same vertex. The spies then do the same. Thereafter the revolutionaries and spies alternate moves with the revolutionaries going first. To move, each revolutionary simultaneously chooses to stay put on its vertex or to move to an adjacent vertex. The spies move in the same way. The goal of the revolutionaries is to place m of their team on some vertex v in such a way that the spies cannot place one of their spies at v in their next move; this is a win for the revolutionaries. If the spies can prevent this forever, they win. There is no hidden information: the positions of all players is known to both sides at all times.

We mention a selection of recent results on this game. We will present the result that if $RS(Z^2, 2, r, s)$ is a win for the spies then $s \geq 6\lfloor \frac{r}{8} \rfloor$. (Here allowable moves in Z^2 consist of one-step horizontal, vertical or diagonal moves.) (Received July 24, 2011)

1073-05-59 **Laura Anderson** (laura@math.binghamton.edu), Department of Mathematical Sciences, Binghamton University, Binghamton, NY 13902, and **Emanuele Delucchi*** (delucchi@math.uni-bremen.de), Fachbereich Mathematik und Informatik, Universitaet Bremen, Bibliothekstrasse 1, 28359 Bremen, Germany. *Complex Matroids.*

A substantial part of the richness of the theory of matroids and oriented matroids lies in the fact that they each can be axiomatized in a number of equivalent - or cryptomorphic - ways. In the last two decades some work has been devoted to the search for a combinatorial abstraction of linear dependency over the complex numbers as a parallel to the corresponding theories for general and real linear dependency, given respectively by matroid theory and oriented matroid theory. We will present our attempt at a theory of complex matroids that shares much of the structural richness of oriented matroid theory. In particular, our theory has several cryptomorphic axiomatizations and a satisfactory notion of duality. Moreover, some of the subtleties arising in the development of this theory shed a new light on known aspects of matroid theory. (Received July 25, 2011)

1073-05-68 **Sogol Jahanbekan**, **Jaehoon Kim** and **Suil O*** (suilo2@math.uiuc.edu), 409 W. Green Street, Urbana, IL 61801, and **Wipawee Tangjai** and **Doulgas B West**. *r-dynamic coloring of graphs.* Preliminary report.

An r-dynamic proper k-coloring of a graph G is a proper k-coloring of G such that every vertex in $V(G)$ has neighbors in at least $\min\{d(v), r\}$ different color classes. The r-dynamic chromatic number of a graph G, written $\chi_r(G)$, is the least k such that G has an r-dynamic proper k-coloring. Our main result in this talk is that if G is a k-regular graph and $k \geq 7r \ln r$, then $\chi_r(G) \leq r\chi(G)$, where $\chi(G)$ is the chromatic number of G. In addition, we study the 2-dynamic chromatic number of a graph and the r-dynamic chromatic number of the cartesian product of two graphs. (Received July 26, 2011)

1073-05-69 **John Goldwasser*** (jgoldwas@math.wvu.edu) and **John Talbot**. *Vertex Ramsey problems in the hypercube.*

We think of the vertices of the n-cube as the set of all subsets of 1,2,3,. . . ,n. We say a subset S of the vertices of the d-cube is t-cube-Ramsey if for sufficiently large n, whenever the vertices of the n-cube are colored with t colors, there must be an embedded monochromatic copy of S. If all sets in S have the same size, then it follows immediately from Ramsey's theorem that S is t-cube-Ramsey, for all t. If S contains sets of different parities then it is not 2-cube-Ramsey, because of the all odd size vertices red and all even size vertices blue coloring. In general it is quite difficult to determine if a set S is t-cube-Ramsey. We determine which sets S which are the union of two or three vertex disjoint cliques are 2-cube-Ramsey. We use the Lovasz local lemma to show that no set which is the union of at least 40 vertex disjoint cliques can be 2-cube-Ramsey. We say a t-coloring of the vertices of the d-cube is layered if all the vertices of the same size get the same color. A key ingredient in our proofs is the following: For each positive integer d, there exists a positive integer N such that for each n greater than N, in every t-coloring of the vertices of the n-cube there is an embedded copy of a d-cube with a layered coloring (Received July 26, 2011)

1073-05-73 **Paul Horn*** (phorn@mathcs.emory.edu), **Václav Koubek** and **Vojtěch Rödl**. *Edge disjoint isomorphic subgraphs in uniform hypergraphs.*

We show that any k-uniform hypergraph with n edges contains two isomorphic, edge disjoint subgraphs of size $\tilde{\Omega}(n^{2/(k+1)})$ for $k = 4, 5$ and 6. Our result is best possible up to a logarithmic factor due to a upper bound construction of Erdős, Pach, and Pyber who show there exist k-uniform hypergraphs with n edges and with no two edge disjoint isomorphic subgraphs with size larger than $\tilde{O}(n^{2/(k+1)})$. This furthermore extends earlier results of Erdős, Pach and Pyber who also established the lower bound for $k = 2$ (ie. for graphs) and of Gould and Rödl who established the lower bound for $k = 3$. (Received July 26, 2011)

1073-05-83 **Linyuan Lu*** (lu@math.sc.edu), Columbia, SC 29208, and **Xing Peng**. *High-ordered Random Walks and Generalized Laplacians on Hypergraphs.*

Despite of the extreme success of the spectral graph theory, there are relatively few papers applying spectral analysis to hypergraphs. Chung first introduced Laplacians for regular hypergraphs and showed some useful applications. Other researchers treated hypergraphs as weighted graphs and then studied the Laplacians of the corresponding weighted graphs. In this paper, we aim to unify these very different versions of Laplacians for hypergraphs. We introduce a set of Laplacians for hypergraphs through studying high-ordered random walks on hypergraphs. We prove the eigenvalues of these Laplacians can effectively control the mixing rate of high-ordered random walks, the generalized distances/diameters, and the edge expansions. (Received July 27, 2011)

1073-05-85 **Stephen Griffeth*** (sgriffeth@inst-mat.utalca.cl), Instituto de Matematica y Fisica, Talca, Chile. *Unitary representations of rational Cherednik algebras of classical type.*

We discuss how a certain Specht-module valued generalization of Jack polynomial may be used to classify the unitary irreducible modules in category O for the rational Cherednik algebras of "classical type", corresponding to the monomial reflection groups. As in the classification of unitary modules in other areas of Lie theory, the unitary modules are classified into families of varying codimensions in the parameter space, with the most complicated ones occurring at isolated points. (Received July 27, 2011)

1073-05-89 **T. Scott Spencer*** (tsspence@unca.edu) and **Neal Stoltzfus**. *The Bollobás-Riordan-Whitney-Tutte Polynomials and the Iterated Two Sum Operation.* Preliminary report.

Given a ribbon graph $\mathbb{D}$ and a collection of pointed ribbon graphs $\mathbb{M}_r$for each edge of $\mathbb{D}$, Farmer has defined the generalized iterated parallel connection and iterated two sum. Essentially, this replaces each edge in $\mathbb{D}$ by the chosen ribbon graph (with the edge deleted for the two-sum). Brylawski developed these ideas of series and parallel connections in graph theory and found formulae for their Tutte polynomial (essential for computational complexity results on the Jones polynomial) . We extend these formulae to the topological rank polynomial of Bollobas-Riordan-Whitney-Tutte for ribbon graphs. The explicit formulae are expressed in terms of the three polynomial constituents of the pointed ribbon graph polynomial of Farmer and a two stage decomposition of the base ribbon graph $\mathbb{D}$. (Received July 27, 2011)

1073-05-92 **Jean-Christophe Novelli***, Batiment Copernic, IGM – Universite de Marne-La-Vallee, 77454 Marne La Vallee, France. *Realizations of combinatorial Hopf algebras.*

We illustrate in this talk the usefulness of the concept of alphabet realization and specialisation on Hopf algebras by a large set of examples. Commutative or on-commutative alphabets, simply of doubly-indexed will be considered. We shall begin with examples on compositions, binary trees, permutations and end with the most recent example, the realization of the Connes-Kreimer Hopf algebra. (Received July 28, 2011)

1073-05-96 **Yair Caro**, **Douglas B. West*** (west@math.uiuc.edu) and **Raphael Yuster**. *Equitable orientations of hypergraphs.*

An *orientation* of a hypergraph chooses for each edge a linear ordering of its vertices. For $1 \le p < r$, an orientation of an r-uniform hypergraph is *p-equitable* if for each p-set of vertices, the numbers of times it occupies the various p-sets of positions differ by at most 1. We prove that every r-uniform hypergraph has 1-equitable and $(r-1)$-equitable orientations. The special case $r = 2$ (graphs) is well known, stating that some orientation has indegree and outdegree differing by at most 1 at each vertex. For $1 < p < r-1$, we prove a necessary condition, implying that some complete r-uniform hypergraphs have no p-equitable orientation. We conjecture that when p and k are fixed and each p-set of vertices appears in at most k edges, p-equitable orientations always exist when r is sufficiently large. We use the Local Lemma to prove that large enough r ensures an orientation that is "nearly" p-equitable, with each p-set of vertices occupying each p-set of positions at most twice. (Received July 28, 2011)

1073-05-98 **Eva Czabarka**, **Peter L Erdos**, **Virginia Johnson*** (johnsonv@mailbox.sc.edu) and **Vincent Moulton**. *Counting gene trees.*

Gene trees used in biology to describe the evolution of genetic material throughout different species. Internal nodes of the tree correspond to speciation or duplication events, and the leaves are labeled with the name of the species the gene comes from. Consequently, gene trees are leaf-labeled trees which ideally but not necessarily are rooted, the root is the only vertex that may have degree 2, and labels in the label set may be used multiple times or not at all (the latter corresponding to deletion events). Otter in 1949 has proved a formula on unlabeled trees that connects counts of rooted trees to corresponding counts of unrooted trees. We generalize this formula for semi-labeled graphs, and use this to provide ordinary generating functions for gene trees (binary or non-binary, rooted or unrooted) and leaf-labeled trees (where internal nodes may have degree 2 even if they are not the root) (Received July 28, 2011)

1073-05-99 **David C Haws*** (dchaws@gmail.com), UNIVERSITY OF KENTUCKY, Department of Statistics, Lexington, KY 40506-0027. *Volumes and Tangent Cones of Matroid Polytopes.*

De Loera et. al. 2009, showed that when the rank is fixed the Ehrhart polynomial of a matroid polytope can be computed in polynomial time when the number of elements varies. A key to proving this is the fact that the number of simplicial cones in any triangulation of a tangent cone is bounded polynomially in the number of elements when the rank was fixed. The authors speculated whether or not the Ehrhart polynomial could be computed in polynomial time in terms of the number of bases, where the number of elements and rank are allowed to vary. We show here that for the uniform matroid of rank r on n elements, the number of simplicial cones in any triangulation of a tangent cone is $\binom{n-2}{r}$. Therefore, if the rank is allowed to vary, the number of simplicial cones grows exponentially in n. Thus, it is unlikely that a Brion-Lawrence type of approach, such as Barvinok's Algorithm, can compute the Ehrhart polynomial efficiently when the rank varies with the number of elements. To prove this result, we provide a triangulation in which the maximal simplicies are in bijection with the spanning thrackles of the complete bipartite graph $K_{r,n-r}$. (Received July 28, 2011)

1073-05-101 **David Galvin*** (dgalvin1@nd.edu), University of Notre Dame, and **Do Trong Thanh**, University of Notre Dame. *Graph Stirling numbers.* Preliminary report.

For a graph G and an integer k, the *graph Stirling number* $S(G,k)$ is the number of partitions of $V(G)$ into k non-empty independent sets. Equivalently it is the number of proper colourings of G using exactly k colours, with two colourings identified if they differ only on the names of the colours. If G is the empty graph on n vertices then $S(G,k)$ is just $S(n,k)$, the Stirling number of the second kind.

Harper showed that the Stirling numbers are asymptotically normal: if X_n takes value k with probability proportional to $S(n,k)$, then $(X_n-\mu_n)/\sigma_n$ tends in distribution to a standard normal (where μ_n and σ_n are the mean and standard deviation of X_n). We obtain an analog of this result for Stirling numbers of forests with not too many components. The first step is to show that the generating function of the sequence of Stirling numbers of a forest has all real roots. This is a consequence of a result of Brenti; we give a more direct proof that exhibits some nice patterns among the roots.

We also consider Stirling numbers of cycles. An involved argument of Brenti, Royle and Wagner established that the sequence of Stirling numbers of a cycle is log-concave; we give a very direct proof. (Joint work with Do Trong Thanh.) (Received July 28, 2011)

1073-05-104 **Nicholas Loehr**, **Luis Serrano** and **Gregory S. Warrington*** (gregory.warrington@uvm.edu), Department of Mathematics and Statistics, University of Vermont, 16 Colchester Ave., Burlington, VT 05401. *Prismatic transition matrices.*

Much of the richness of the ring of symmetric functions and the ring of quasi-symmetric functions is embodied in the transition matrices between various pairs of bases. In this talk we give combinatorial interpretations for the entries of certain such matrices involving either the Hall-Littlewood symmetric functions or the quasi-symmetric analogues of them defined by F. Hivert. (Received July 29, 2011)

1073-05-105 **Gregory S. Warrington*** (gregory.warrington@uvm.edu), Department of Mathematics & Statistics, University of Vermont, 16 Colchester Ave., Burlington, VT 05401. *Kazhdan-Lusztig polynomials and their μ-coefficients.*

Kazhdan-Lusztig polynomials encode important information about the intersection cohomology of Schubert varieties as well as the multiplicities for Verma modules. Unfortunately, there are still enormous gaps in our combinatorial understanding of these polynomials. In this talk I discuss some results relating to their "μ-coefficients". These coefficients, which are central to Kazhdan and Lusztig's construction of the irreducible

representations of the symmetric group, control the recursive structure of the Kazhdan-Lusztig polynomials. (Received July 29, 2011)

1073-05-107 **June Huh*** (junehuh@umich.edu). *Characteristic polynomials and the Bergman fan of matroids.*

Let V be a subvariety of the torus. The asymptotic behavior of the amoeba of V is given by a polyhedral fan called the Bergman fan of V. We use the tropical geometry of the Bergman fan to prove the log-concavity conjecture of Rota and Welsh over any field. This work is joint with Eric Katz and is based on arXiv:1104.2519. (Received July 29, 2011)

1073-05-109 **Amanda Lee Coe*** (acoe2@elon.edu), 7624 Campus Box, Elon, NC 27244. *Pascal's Triangle in Higher Dimensions.*

Geometric displays of binomial coefficients are famously seen in Pascal's Triangle. This display has been extended by Hilton to include trinomials. There are many patterns in Pascal's Triangle, including the Star of David Theorem. Unique to this paper are displays of 4-nomial coefficients and patterns in $\mathbb{Z}_p$, for p a prime, in 4-nomials, and an extension of the Star of David Theorem for trinomial coefficients. (Received July 29, 2011)

1073-05-110 **Nathan Reading*** (nathan_reading@ncsu.edu) and **David E Speyer**. *Cambrian models for cluster algebras.*

Cluster algebras are certain commutative rings generated by a collection of rational functions called *cluster variables*. The cluster variables are determined recursively from a small amount of initial combinatorial data. We will show how combinatorial models of cluster algebras (of finite and affine type) arise from the combinatorics of Coxeter groups, and specifically, sortable elements and Cambrian lattices. (Received July 29, 2011)

1073-05-115 **Carl R Yerger*** (cayerger@davidson.edu), Department of Mathematics, Box 7059, Davidson, NC 28036, and **Dan Cranston** and **Luke Postle**. *Modified Linear Programming Weighting for Graph Pebbling.* Preliminary report.

Given a configuration of pebbles on the vertices of a connected graph G, a *pebbling move* is defined as the removal of two pebbles from some vertex and the placement of one of these on an adjacent vertex. The *pebbling number* of a graph G is the smallest integer k such that for each vertex v and each configuration of k pebbles on G there is a sequence of pebbling moves that places at least one pebble on v. We improve on results of Hurlbert who introduced a linear optimization technique for graph pebbling. In particular, we utilize a different set of weight functions that use graphs more general than trees. As a proof-of-concept, we apply this new lemma to some graphs from Hurlbert's paper and show both improvements to Hurlbert's bounds and possible limitations of this method. (Received July 29, 2011)

1073-05-118 **Csaba Biro*** (csaba.biro@louisville.edu), **Paul Horn** and **D. Jacob Wildstrom**. *Extremal Aspects of Hajnal's Triangle Free Game.* Preliminary report.

Hajnal's triangle free game starts on the empty graph on n vertices. Two players take turns in adding edges to the graph while keeping the graph triangle free. In Hajnal's original game, the player who could not make a valid move lost the game. Füredi, Reimer, and Seress proposed a variation, in which the goal of one of the players is to prolong the game, and the goal of the other player is to finish the game as soon as possible. They proved that the game will last at least on the order of $n \log n$ steps. On the other hand, an unpublished result by Erdős states that the game will last at most $n^2/5$ steps. In this paper we make a slight improvement on Erdős's upper bound and we discuss related problems. (Received July 29, 2011)

1073-05-120 **Jerrold R. Griggs*** (j@sc.edu), Department of Mathematics, University of South Carolina, Columbia, SC 29208, and **Wei-Tian Li** and **Linyuan Lu**. *Forbidden subposets with nice answers.* Preliminary report.

We consider the problem of determining the largest size $\mathrm{La}(n, H)$ of a family of subsets of $[n] := \{1, \ldots, n\}$ that contains no (weak) subposet isomorphic to a given poset H. For some posets H we may know $\mathrm{La}(n, H)$ exactly for all $n > n_o$, and in such cases, it may be simply the sum of the k middle binomial coefficients in n, where k and n_o depend on H. This is true for chains and for the four-element butterfly poset. For other posets H, such as the three-element poset V, we can describe the asymptotic behavior of $\mathrm{La}(n, H)$, even though it appears to be exceedingly difficult to determine $\mathrm{La}(n, H)$ more precisely. In all known cases, we have $\lim_{n\to\infty} \mathrm{La}(n, P)/\binom{n}{\lfloor n/2 \rfloor}$ exists and is integral. Finally, there are posets H that seem to be more difficult, such as the four-element diamond D_2, for which the existence of $\lim_{n\to\infty} \mathrm{La}(n, P)/\binom{n}{\lfloor n/2 \rfloor}$ remains open. In recent progress, we can add various infinite families of posets H to the list of those which can be completely solved. (Received July 29, 2011)

1073-05-135 **Andrew Berget*** (berget@math.ucdavis.edu) and **Alex Fink**. *On projective equivalence classes of matrices.* Preliminary report.

We consider the projective equivalence class of an r-by-n matrix v, whose columns are thought of as a realization of a rank r matroid on n elements. The Zariski closure of such an equivalence class is an affine variety that caries the action of a linear algebraic group. In this talk I will describe a set of equations that cut out this variety as well its boundary points. (Received July 30, 2011)

1073-05-136 **Richard Hammack*** (rhammack@vcu.edu), Virginia Commonwealth University, Dept. of Mathematics and Applied Mathematics, Box 842014, Richmond, VA 23284. *The factorial of a graph.*

In 1971 Lovász proved the following cancellation law for the direct product of graphs: If A, B and C are graphs, then $A \times C \cong B \times C$ implies $A \cong B$, provided C has an odd cycle. This gives exact conditions on C that govern whether cancellation holds or fails.

Left unresolved were the conditions on A (or B) that guarantee cancellation. We introduce a new construction, called the *factorial of a graph*, that settles this issue.

The factorial of a graph A is a certain graph $A!$ defined on the set Perm(A) of permutations of $V(A)$. We define the edges and indicate some parallels to the factorial operation on integers. In fact, the edge set $E(A!)$ is a group that acts naturally on Perm(A). We show how (for bipartite C) the orbits of this action are in one-to-one correspondence with the graphs B for which $A \times C \cong B \times C$; if the action is transitive, then cancellation holds.

In addition to solving the cancellation problem, the factorial raises many interesting questions. Given a finite group G, is there a graph A with $E(A!) \cong G$? Can we characterize those A for which $E(A!)$ is (say) abelian? Are such questions significant or mere curiousities? There are more unknowns than knowns. (Received July 30, 2011)

1073-05-139 **Bela Csaba***, School of Mathematics, University of Birmingham, Birmingham, B15 2TT, England. *An Ore-type packing problem.* Preliminary report.

Let G and H be two graphs on n vertices. Let $\theta(G) = \max_{xy \in E(G)}\{deg_G(x) + deg_G(y)\}$, the Ore-degree of G. Let $\Delta(H)$ be the maximum degree of H. A theorem of Kostochka and Yu states that if $\theta(G)\Delta(H) < n$ then there is an edge-disjoint placement of G and H into K_n. We show a strengthening of the above in a special case: if $\theta(G) \leq 5$, $\Delta(H) \leq n/4$ and n is sufficiently large, then there is an edge-disjoint placement of G and H into K_n. (Received July 30, 2011)

1073-05-144 **Dwight Duffus*** (dwight@mathcs.emory.edu), Math & CS Dept, Emory University, Atlanta, GA 30322, and **Jeremy McKibben-Sanders** (jmckib2@gmail.com) and **Kyle Thayer** (kthayer@emory.edu). *Some quotients of the Boolean lattice are symmetric chain orders.*

There are several well-known combinatorial problems that amount to determining whether quotients of the Boolean lattice B_n defined by subgroups of the symmetric group S_n have symmetric chain decompositions. Indeed, R. Canfield has conjectured that for all subgroups G of S_n, the quotient order $B(n)/G$ is a symmetric chain order.

We provide a straightforward proof of a generalization of a result of K. K. Jordan: namely, B_n/G is an SCO whenever G is generated by powers of disjoint cycles. The symmetric chain decompositions of Greene and Kleitman provide the basis for partitions of these quotients. We also show that some other "small" subgroups of S_n have the same property. (Received July 31, 2011)

1073-05-145 **Aba Mbirika*** (ambirika@bowdoin.edu) and **Julianna Tymoczko**. *Truncated symmetric functions with an application to generalized Springer theory.*

Symmetric functions are polynomials in the ring $\mathbb{Z}[x_1, x_2, \ldots, x_n]$ that are fixed by a natural action of the symmetric group $\mathfrak{S}_n$ on the variables $\{x_1, x_2, \ldots, x_n\}$. Truncated symmetric functions, on the other hand, are polynomials symmetric in a subset of these variables. The main objects of our interest are truncated elementary symmetric functions (TESF) and truncated complete symmetric functions (TCSF). In this talk, we give a number of identities involving these functions and a remarkable identity relating TESF to TCSF. From the family of TESF, we construct ideals that generalize the Tanisaki ideal which arises in Springer theory. From the family of TCSF, we build Gröbner bases for this family of generalized Tanisaki ideals. The corresponding polynomial quotient rings easily yield the Betti numbers for the cohomology rings of an important generalization of the Springer variety, called regular nilpotent Hessenberg varieties. (Received July 31, 2011)

1073-05-147 **Stefan Felsner** and **William T Trotter*** (trotter@math.gatech.edu), William T. Trotter, School of Mathematics, Georgia Institute of Technology, Atlanta, GA 30332, and **Veit Wiechert**. *Planarity for Comparability Graphs and Cover Graphs.*

It is well known that for every positive integer t, there exists a planar poset P_t so that the dimension of P_t is t. Streib and Trotter have shown that for every $h \geq 2$, there exists a contant c_h so that if P is a poset with a planar cover graph and the height of P is at most h, then the dimension of P is at most c_h. Here we show that if P is poset with a planar comparability graph, then the dimension of P is at most 4. We also show that if P has an outerplanar cover graph, then the dimension of P is at most 4. Finally, if P has an outerplanar cover graph and the height of P is 2, then the dimension of P is at most three. These three inequalities are all best possible. (Received July 31, 2011)

1073-05-154 **Qinghai Liu**, College of Mathematics and System Sciences, Xinjiang University, Urumqi, Xinjiang 830046, Peoples Rep of China, **Xingxing Yu*** (yu@math.gatech.edu), School of Mathematics, Georgia Institute of Technology, Atlanta, GA 30332, and **Zhao Zhang**, College of Mathematics and System Sciences, Xinjiang University, Urumqi, Xingjiang 830046, Peoples Rep of China. *Bounding the circumference of 3-connected cubic graphs.*

Jackson solved a conjecture of Bondy by showing that every 3-connected cubic graph of order n has a cycle of length $\Omega(n^{0.694})$. Bilinski et al. improved this lower bound to $\Omega(n^{0.753})$. In this paper, we further improve this lower bound to $\Omega(n^{0.8})$. This is done by obtaining more structural information, considering cycles through two given edges, and distinguishing the cases whether these edges are adjacent or not. We also show that every 3-edge-connected graph of order n contains an Eulerian subgraph of size $\Omega(n^{0.8})$. (Received July 31, 2011)

1073-05-167 **Stephen G Hartke** and **Derrick P Stolee*** (s-dstolee1@math.unl.edu). *Searching for uniquely saturated and strongly regular graphs with coupled augmentations.* Preliminary report.

When human-generated constructions and theorems fail to decide existence or non-existence, we use computational tools to search for uniquely saturated or strongly regular graphs. We adapt the technique of orbital branching which was originally developed for use in solving symmetric integer programs. Our extension uses augmentations which are coupled to the constraint system in order to exploit symmetries. We augment by *K_r-completions* to find uniquely K_r-saturated graphs and augment by *λ- or μ-augmentations* to find strongly regular graphs and digraphs. (Received July 31, 2011)

1073-05-171 **Zoltan Furedi** (z-furedi@math.uiuc.edu), **Tao Jiang*** (jiangt@muohio.edu) and **Robert Seiver** (seiverrs@muohio.edu). *Hypergraph Turan numbers of uniform linear paths.*

Given a k-uniform hypergraph (or a k-graph for short) H and a positive integer n, the Turán number $ex_k(n, H)$ of H is the maximum number of edges in a k-graph $\mathcal{F}$ on n vertices that does not contain H as a subhypergraph. The Turán problem for hypergraphs is difficult and $ex_k(n, H)$ is asymptotically determined only for very few graphs. Exact values are known only for a handful of k-graphs H, most of which are on a small number of vertices.

A k-uniform linear path $\mathcal{P}_\ell^k$ of length ℓ is a k-graph with hyperedges $F_1, \ldots, F_\ell$ such that $|F_i \cap F_{i+1}| = 1$ for all i and $F_i \cap F_j = \emptyset$ whenever $|i - j| > 1$. Frankl determined $ex_k(n, \mathcal{P}_\ell^k)$ when $\ell = 2$. Here, we determine $ex_k(n, \mathcal{P}_\ell^k)$ exactly for all fixed $\ell \geq 1, k \geq 4$, and sufficiently large n. We show that $ex_k(n, \mathcal{P}_{2t+1}^k) = \binom{n-1}{k-1} + \binom{n-2}{k-1} + \ldots + \binom{n-t}{k-1}$ and $ex(n, \mathcal{P}_{2t+2}^k) = \binom{n-1}{k-1} + \binom{n-2}{k-1} + \ldots + \binom{n-t}{k-1} + \binom{n-t-2}{k-2}$. We also describe the unique extremal graphs and establish stability results on these bounds. Our main method is the delta-system method. (Received August 02, 2011)

1073-05-174 **J Balogh** and **J Butterfield*** (jbutter2@illinois.edu), Department of Mathematics, 1409 W. Green St, Urbana, IL 61801, and **P Hu**, **J Lenz** and **D Mubayi**. *On the Chromatic Thresholds of Hypergraphs.*

Let F be a family of r-uniform hypergraphs. The chromatic threshold of F is the infimum of all non-negative real numbers c such that the subfamily of F comprising hypergraphs H with minimum degree at least $c\binom{|V(H)|}{r-1}$ has bounded chromatic number. This parameter has a long history for graphs ($r = 2$), and we begin its systematic study for hypergraphs.

Łuczak and Thomassé recently proved that the chromatic threshold of near bipartite graphs is zero, and our main contribution is to generalize this result to r-uniform hypergraphs. In an attempt to generalize Thomassen's result that the chromatic threshold of triangle-free graphs is 1/3, we prove bounds for the chromatic threshold of the family of 3-uniform hypergraphs not containing $\{abc, abd, cde\}$, the so-called generalized triangle.

In order to prove upper bounds we introduce the concept of fiber bundle dimension, based on the idea of Vapnik-Chervonenkis dimension in hypergraphs. Our lower bounds follow from explicit constructions,many of which use a generalized Kneser hypergraph. Using methods from extremal set theory, we prove that these generalized Kneser hypergraphs have unbounded chromatic number. This generalizes a result of Szemerédi for graphs. (Received August 01, 2011)

1073-05-178 **Steve Butler*** (butler@ucsd.edu), Department of Mathematics, Iowa State University, and **Ron Graham**. *Avoiding patterns with coloring.*

We look at avoiding monochromatic patterns in coloring of $[n]$. (Received August 01, 2011)

1073-05-180 **Gexin Yu*** (gyu@wm.edu), Williamsburg, VA. *Routing numbers of paths and cycles.* Preliminary report.

Let G be a connected graph. Initially, each vertex v of G is occupied by a "pebble" that has a unique destination $\pi(v)$ in G (so that π is a permutation of the vertices of G). It is required that all the pebbles be routed to their respective destinations by performing a sequence of moves of the following type: A disjoint set of edges is selected, and the pebbles at each edge's endpoints are interchanged. Define $rt(G, \pi)$ to be the minimum number of steps to route the permutation π and the routing number $rt(G)$ of G to be the maximum of $rt(G, \pi)$ over all permutation π. In this talk, we will consider the routing numbers of paths and cycles. (Received August 01, 2011)

1073-05-186 **Amanda Ruiz*** (aruiz@math.binghamton.edu). *Realizations of Complex Matroids.*

Complex matroids are combinatorial objects, recently defined by Anderson and Delucchi, that play the same role for complex vector spaces as oriented matroids do for real vector spaces. A complex matroid is a matroid with additional structure that generalizes orientation.

According to Mnëv's Universality Theorem, for those complex matroids which are complexified oriented matroids, the realization space can be arbitrarily complicated. For all other complex matroids, the realizations are rigid; that is, the realization space is a single point. (Received August 01, 2011)

1073-05-187 **hoda bidkhori*** (hbidkho@ncsu.edu), 1009 Wade Ave, Apt 455, Raleigh, NC 27605. *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 it a lattice path matroid.

We investigate properties of lattice path matroid polytopes, the polytope associated to these matroids. This incluse their face structure, their decomposition and triangulation as well as formula for calculating their Ehrhart polynomial and volume. (Received August 01, 2011)

1073-05-198 **Daniel W Cranston**, **Jaehoon Kim** and **William B Kinnersley*** (wkinner2@illinois.edu). *t-Tone Coloring of Graphs.*

A t-tone k-coloring of G assigns to each vertex of G a set of t colors from $\{1, \ldots, k\}$ so that vertices at distance d share fewer than d common colors. The *t-tone chromatic number* of G, denoted $\tau_t(G)$, is the minimum k such that G has a t-tone k-coloring. Bickle and Phillips posed several conjectures regarding the relationship between $\tau_2(G)$ and $\Delta(G)$; we confirm one, refute another, and explore a third. In particular we show that $\tau_2(G) \leq \left\lceil (2+\sqrt{2})\Delta(G) \right\rceil$ for all G and that $\tau_2(G) \leq 8$ when $\Delta(G) \leq 3$. For general t, we give upper bounds on $\tau_t(G)$ in terms of $\Delta(G)$ over several classes of graphs. (Received August 01, 2011)

1073-05-201 **Joshua N Cooper*** (cooper@math.sc.edu), 1523 Greene St, LeConte College, USC, Columbia, SC 29201, and **Aaron Dutle**. *Spectra of Hypergraphs.*

We present a spectral theory of hypergraphs that closely parallels graph spectral theory. Classic work by Gelfand-Kapranov-Zelevinsky and Canny, as well as more recent developments by Chang, Friedland, Lim, Pearson, Qi, Zhang, and others has led to a rich understanding of "hyperdeterminants" of hypermatrices, a.k.a. multidimensional arrays. Hyperdeterminants share many properties with determinants, but the context of multilinear algebra is substantially more complicated than the linear algebra required to understand spectral graph theory (i.e., ordinary matrices). Nonetheless, it is possible to define eigenvalues of a tensor via its characteristic polynomial and variationally. We apply this notion to the "adjacency hypermatrix" of a uniform hypergraph, and prove a number of natural analogues of graph theoretic results. Computations are particularly cumbersome with hyperdeterminants and resultants, so we discuss software developed in Sage which can perform basic calculations on small hypergraphs. Open problems abound, and we present a number of directions for research.

Joint work with Aaron Dutle of the University of South Carolina. (Received August 01, 2011)

1073-05-204 **Allen Knutson*** (allenk@math.cornell.edu). *Positroids, shifting, and a combinatorial Vakil's "geometric Littlewood-Richardson rule".*

Erdős-Ko-Rado defined a "shifting" operation $i \to j$ on collections from $\binom{[n]}{k}$; loosely speaking, one turns is into js unless something's in the way. The "shifted" (or "Schubert") matroids that are invariant under all shifts with $i < j$ are the ones whose coloop-free flats are initial intervals $[1, j]$. An *interval positroid* is a matroid on $[1, n]$ all of whose coloop-free flats are intervals $[i, j]$, a particularly nice class that includes lattice path matroids.

A shift M' of a matroid M on $[1, n]$ is usually not a matroid (though the "sweep" $M \cup M'$ is). I'll explain why it's algebro-geometrically interesting to look for the maximal submatroids of a non-matroid such as M'.

Then I'll define (partially filled) "puzzles", and associate an interval positroid to each one. Filling in a puzzle piece corresponds to shifting the matroid, then decomposing the collection into maximal submatroids. This is a combinatorial way of following Vakil's "geometric Littlewood-Richardson rule". (Received August 01, 2011)

1073-05-205 **Cun-Quan Zhang*** (cqzhang@math.wvu.edu), Department of Mathematics, WVU, Morgantown, WV 26506-6310. *Strong embedding of semi-Petersen-minor free graph.* Preliminary report.

Let P_{10} be the Petersen graph, and P_{10}^- be the graph obtained from P_{10} by contracting one edge. It is proved by Alspach and Zhang that every bridgeless cubic P_{10}-minor free graph has a strong embedding on some surface. For bridgeless graphs without the regularity requirement, it was proved by Zhang that every K_5-minor free graph has a strong embedding on some surface. In this paper, this result is generalized for graph without P_{10}^--minor. (Received August 01, 2011)

1073-05-207 **Matthew T. Stamps*** (mtstamps@math.ucdavis.edu), University of California, Davis. *On weak maps and Whitney numbers of matroids.*

We give a topological proof that for any matroid M, the Whitney numbers of the first kind of M are greater than or equal to those of any weak map image of M, a result previously shown by Kung using algebraic techniques. This work utilizes a recent construction of Engström for obtaining topological representations of matroids via diagrams of spaces. In particular, we show that the Whitney numbers of the first kind of M are encoded in the Betti numbers of the codimension two homotopy sphere arrangement of M and that every surjective weak map between matroids induces a surjective cellular mapping between their topological representations. (Received August 01, 2011)

1073-05-209 **Louis DeBiasio*** (debiasld@muohio.edu), **Andrzej Czygrinow** and **Brendan Nagle**. *Tiling 3-uniform hypergraphs.*

We say a hypergraph H can be *tiled* with a hypergraph F if H contains $\frac{|H|}{|F|}$ vertex disjoint copies of F (we will suppose that $|H|$ is divisible by $|F|$). Let $t_\ell^k(n, F)$ be the smallest integer d so that any k-uniform hypergraph H on n vertices with $\delta_\ell(H) \geq d$ can be tiled with F (where $\delta_\ell(H)$ is the minimum ℓ-degree of the hypergraph H). For graphs, $t_1^2(n, F)$ is known up to an additive constant for every graph F due to a result of Kühn and Osthus. Furthermore $t_1^2(n, F)$ is known exactly for some graphs – notably the Hajnal-Szemerédi theorem implies that $t_1^2(n, K_t) = (1 - \frac{1}{t})n$.

In hypergraphs, much less is known about the tiling problem and in this talk I will mainly focus on what is known about $t_2^3(n, F)$. There are a few graphs F for which $t_2^3(n, F)$ is known asymptotically and only one graph F for which $t_2^3(n, F)$ is known exactly. After giving a survey, I will discuss our proof of an exact result for $t_2^3(n, C_4)$, where C_4 is the 3-uniform hypergraph on 4 vertices with 2 edges. (Received August 01, 2011)

1073-05-214 **Andrew Treglown** and **Yi Zhao*** (yzhao6@gsu.edu), Department of Mathematics and Statistics, Georgia State University, Atlanta, GA 30338. *Perfect matchings in uniform hypergraphs.*

Given positive integers k and ℓ where 4 divides k and $k/2 \leq \ell \leq k - 2$, we determine the minimum ℓ-degree threshold that ensures a perfect matching in a k-uniform hypergraph. This improves on work of Pikhurko who determined this threshold asymptotically. Our approach makes use of the Hypergraph Removal Lemma as well as a structural result of Keevash and Sudakov relating to the Turán number of expanded triangles. (Received August 01, 2011)

1073-05-221 **Dong Ye*** (dye@math.wvu.edu), Department of Mathematics, West Virginia University, Morgantown, WV 26506, and **Cun-Quan Zhang** (cqzhang@math.wvu.edu), Department of Mathematics, West Virginia University, Morgantown, WV 26506. *Circumference and Cycle Double Cover.*

Let G be a bridgeless cubic graph with n vertices. The circumference of G is the size of a longest circuit of G. By using computers, Hägglund and Markström verified that G has a cycle double cover if its circumference is at

least $n-10$. In this talk, we give a direct proof to show that a cubic graph G with circumference at least $n-8$ has a cycle double cover. (Received August 02, 2011)

1073-05-225 **Jay Schweig*** (jschweig@math.ku.edu), KU Math Dept., Lawrence, KS 66045. *Algebraic Properties of Lattice Path Matroids and Polymatroids.*

Lattice path matroids are transversal matroids whose bases can be interpreted as certain planar lattice paths. We discuss some algebraic results concerning these matroids, proving a special case of White's conjecture on the generating sets of toric ideals associated to the bases of these matroids. We then generalize to a related class of discrete polymatroids, and discuss possible approaches to White's conjecture for other classes of matroids. No prior knowledge of toric ideals or polymatroids will be assumed. (Received August 02, 2011)

1073-05-227 **Ezra Miller*** (ezra@math.duke.edu). *Subword complexes and fibers of totally nonnegative parametrizations.* Preliminary report.

Connections between subword complexes and parametrizations of totally nonnegative parts of unipotent radicals give rise to an interesting perspective on regular CW decompositions of such spaces. (Joint work in progress with P. Hersh.) (Received August 02, 2011)

1073-05-228 **Florian Pfender**, **Kevin G Milans*** (milans@math.sc.edu), **Dieter Rautenbach**, **Friedrich Regen** and **Douglas B West**. *Cycle Spectra of Hamiltonian Graphs.* Preliminary report.

The *cycle spectrum* of a graph G is the set of lengths of cycles in G. Let $s(G)$ denote the size of the cycle spectrum of G. We show that if G is a graph with a spanning cycle and p chords, then $s(G) \geq \sqrt{p} - \frac{1}{2}\ln p - 2$. The result is asymptotically sharp when G is the complete bipartite graph $K_{n,n}$ and $p = n^2 - 2n$, since then $s(G) = \sqrt{p+1}$. (Received August 02, 2011)

1073-05-231 **Chris Berg**, **Nantel Bergeron**, **Hugh Thomas** and **Mike Zabrocki*** (zabrocki@mathstat.yorku.ca). *Expansion of k-Schur functions for maximal k-rectangles within the affine nilCoxeter algebra.*

The k-Schur functions were introduced by Lapointe, Lascoux and Morse in 2003 as an approach to finding a combinatorial interpretation of the Macdonald q,t-Kostka coefficients. Since then there have been two additional conjecturally equivalent definitions of the k-Schur functions proposed. Using one of these definitions (at t=1) T. Lam identified the k-Schur functions as the Schubert basis of the homology of the affine Grassmannian while Lapointe and Morse identified Gromov-Witten invariants as certain special cases of the structure coefficients. An important open problem in this area is to give a combinatorial interpretation for the structure coefficients of these elements. I will explain how the problem can be reduced to expanding the k-Schur functions in the affine nil-Coxeter algebra and I will give a formula for the k-Schur functions indexed by a maximal rectangle. (Received August 02, 2011)

1073-05-235 **Nick Zhao*** (yzhao@mail.ucf.edu), Department of Mathematics, University of Central Florida, Orlando, FL 32816. *Adjacency Lemmas on edge chromatic critical graphs.*

Researchers have used Vizing Adjacency Lemma to deal with edge chromatic critical graphs for almost 40 years and obtained many good results. For the past 10 years, researchers have obtained some new adjacency lemmas. In this talk, we will talk about some of these Adjacency Lemmas obtained after Vizing Adjacency lemma. (Received August 02, 2011)

1073-05-236 **Guantao Chen*** (gchen@gsu.edu), Department of Mathematisc and Statistics, Georgia State University, Atlanta, GA 30303, **Han Ren**, Department of Mathematics, East China Normal University, Shanghai, Peoples Rep of China, and **Songling Shan**, Department of Mathematics and Statistics, Georgia State University, Altanta, GA 30303. *Graphs Containing 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. Hill conjectured that every triangulation of the plane other than K_3 contains a HIST. Malkevitch extended this conjecture to near-triangulations of the plane (2-connected plane graphs such that all, but at most one, faces are triangles). Albertson, Berman, Hutchinson, and Thomassen confirmed the conjecture. Given a surface Π, they asked whether *every triangulation of* Π *contains a HIST*. We show that every connected and locally connected graph with more than 3 vertices contains a HIST. Consequently, a triangulation of any surface contains a HIST. We will also present results regarding the following two questions proposed by Albertson, Berman, Hutchinson, and Thomassen:

(1) Does every graph such that every edge is on at least two triangles contain a HIST?

(2) Is it NP-complete to decide whether a subcubic graph contains a HIST?

(Received August 02, 2011)

1073-05-239 **Jennifer Morse***, Math Department, Drexel University, Philadelphia, PA 19104. *Tableaux family for Macdonald polynomials, Gromov-Witten invariants, and affine K-theory.*

Tableaux family for Macdonald polynomials, Gromov-Witten invariants, and affine K-theory (Received August 02, 2011)

1073-05-246 **Patrick Bennett** and **Tom Bohman*** (tbohman@math.cmu.edu). *A natural barrier for random greedy hypergraph matching.*

Let r be a fixed constant and let $\mathcal{H}$ be an r-uniform, D-regular hypergraph on N vertices. Assume further that co-degrees in $\mathcal{H}$ are at most L where $L = o(D)$. We consider the random greedy algorithm for forming a hypergraph matching; that is, we choose a matching in $\mathcal{H}$ at random by iteratively choosing an edge uniformly at random to be in the matching and deleting all edges that share at least one vertex with the chosen edge before moving on to the next choice. This process terminates when there are no edges remaining in the graph. We show that with high probability the proportion of vertices of $\mathcal{H}$ that are not saturated by the final matching is at most $(L/D)^{\frac{1}{2(r-1)}+o(1)}$. This point is a natural barrier in the analysis of the random greedy hypergraph matching process. (Received August 02, 2011)

1073-05-247 **Martha Yip*** (martha.yip@gmail.com), Philadelphia, PA 19104. *On multiplication formulas for Hall-Littlewood polynomials.* Preliminary report.

Recently, Gaussent and Littelmann introduced the one-skeleton gallery model for computing the expansion of Hall-Littlewood polynomials in terms of orbit sums. Klostermann showed that in the type A case, the Gaussent-Littelmann formula is equivalent to Macdonald's formula in terms of chains of tableaux. We discuss recent work towards a one-skeleton gallery/tableau model for computing structure coefficients of products of Hall-Littlewood polynomials. (Received August 02, 2011)

1073-05-248 **Wenliang Tang*** (victor_251@math.wvu.edu), Dept. of Mathematics, West Virginia Universit, Morgantown, WV 26505, and **Erling Wei** and **Cunquan Zhang**. *On Strong Circuit Double Cover Conjecture with Special Property.* Preliminary report.

Let G be a bridgeless cubic graph and C is any given circuit in G, it was conjectured that we can find a family of circuits $\mathcal{F}$ containing C such that every edge of G is covered exactly by two members of $\mathcal{F}$. This is the well-known *Strong Circuit Double Cover*. In this paper we verified this conjecture on the following two special classes of cubic graphs:

(1) For a pair $(G,\ C)$, if $H = G - C$ contains a Hamilton path of order less than 23, then G has a circuit double cover containing C;

(2) For a pair $(G,\ C)$, if $H = G - C$ contains a Y-tree of order less than 20, then G has a circuit double cover containing C;

(Received August 02, 2011)

1073-05-249 **Susanna D Fishel*** (fishel@math.asu.edu), School of Mathematical & Statistical Sciences, PO Box 871804, Tempe, AZ 85287. *A problem in combinatorial representation theory.*

I will discuss a problem in combinatorial representation theory. (Received August 03, 2011)

1073-05-252 **Hehui Wu*** (noshell@hotmail.com). *Local edge-connectivity and forest decomposition.*

Two vertices u, v are j-edge-connected in a graph G if there are j edge-disjoint u, v-paths in G. A vertex set S of G is j-edge-connected in G if any two vertices in S are j-edge-connected in G. A S-tree is a subtree of G that spans S. Given a family of disjoint vertex set $\mathcal{S} = \{S_1, S_2, \ldots, S_l\}$, a $\mathcal{S}$-forest is a acyclic subgraph of G in which S_i lie in the same component for each i with $1 \leq i \leq l$.

Krisell conjectured that if S is $2k$-edge-connected in G, then G has k edge-disjoint S-trees. More generally, there is a corresponding conjecture about $\mathcal{S}$-packing, and Lap Chi Lau proved that given a family of disjoint vertex set $\mathcal{S} = \{S_1, S_2, \ldots, S_l\}$, if S_i is $32k$-edge-connected in G for each i with $1 \leq i \leq l$, then G has k edge-disjoint $\mathcal{S}$-forests. In a recent paper, West and the speaker proved that if S is 6.5-edge-connected in G, then G has k edge-disjoint S-trees. In this talk, the speaker will extend the result to $\mathcal{S}$-forest packing problem. (Received August 02, 2011)

1073-05-258 **Maria Axenovich*** (axenovic@iastate.edu) and **Lale Ozkahya**. *On homometric sets in graphs.*

Two disjoint vertex sets in a graph are called homometric if they have the same size and if the multisets of pairwise distances between the elements of each set coincide. In particular, in a diameter 2 graph, homometric sets induce the same number of edges. This notion was recently introduced by Albertson, Pach and Young. We investigate the sizes of the largest homometric sets in general graphs, and in some special classes such as trees. This problem, considered for path is a classical problem in number theory. (Received August 03, 2011)

1073-05-265 **Anna S Bertiger*** (annab@math.cornell.edu), Cornell University. *Unions of Matrix Schubert Varieties* Preliminary report.

I will present a method for finding Gröbner bases of unions of matrix Schubert varieties. I will provide lots of examples and relevant definitions. (Received August 05, 2011)

11 ► Number theory

1073-11-17 **Christelle Vincent*** (vincent@math.wisc.edu), Department of Mathematics, 480 Lincoln Drive, Madison, WI 53706. *Weierstrass points on the Drinfeld modular curve $X_0(\mathfrak{p})$.* 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 June 6, 2011)

1073-11-20 **David M Brown*** (david.m.brown.jr@gmail.com). *Explicit modular approaches to generalized Fermat equations.*

Let $a, b, c \geq 2$ be integers satisfying $1/a + 1/b + 1/c > 1$. Darmon and Granville proved that the generalized Fermat equation $x^a + y^b = z^c$ has only finitely many coprime integer solutions; conjecturally something stronger is true: for $a, b, c \geq 3$ there are no non-trivial solutions and for $(a, b, c) = (2, 3, n)$ with $n \geq 10$ the only solutions are the trivial solutions and $(\pm 3, -2, 1)$ (or $(\pm 3, -2, \pm 1)$ when n is even). I'll explain how the modular method used to prove Fermat's last theorem adapts to solve generalized Fermat equations and use it to solve the equation $x^2 + y^3 = z^{10}$. (Received ,)

1073-11-43 **Kevin L James*** (kevja@clemson.edu), BOX 340975, Clemson, SC 29634-0975. *Prime Distribution and Elliptic Curves.*

Number theorists have long been interested in the distribution of prime numbers. The celebrated prime number theorem gives an asymptotic for the number $\pi(X)$ of primes up to any real number X, namely $\pi(X) \sim \frac{X}{\log X}$. There are many refinements of this, such as an asymptotic form of Dirichlet's theorem on primes in arithmetic progressions. The crowning achievement in this direction is the Chebotaryov Density Theorem. Some proposed refinements of this theory related to elliptic curves are the Sato-Tate conjecture recently proved in many cases by Richard Taylor and the Lang-Trotter conjecture.

We briefly review the Lang-Trotter conjecture. 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 $a_E(p) = p + 1 - \#E(\mathbb{F}_p)$. For an integer r and a curve E as above, Lang and Trotter have conjectured that $\#\{p < X \mid a_E(p) = r\} \sim C_{E,r} \frac{\sqrt{X}}{\log X}$, where $C_{E,r}$ is an explicit constant.

In this talk, we will review the results and conjectures mentioned above and their generalizations to number fields, and we will discuss some recent results in these directions. (Received July 19, 2011)

1073-11-61 **Scott Ahlgren*** (ahlgren@math.uiuc.edu), Department of Mathematics, 1409 W. Green St, Urbana, IL 61801. *Mock modular grids and Hecke relations for mock modular forms.*

We consider grids of weak harmonic Maass forms (these are comprised of two infinite families of forms which are "dual" in the sense that reading down the grid gives the coefficients of the first family, while reading across gives the coefficients of the second). As an application, we use Hecke relations among elements of these grids to study identities and congruences for generating functions of interest (for example, the "smallest parts" function of Andrews). This is joint work with Byungchan Kim. (Received July 25, 2011)

1073-11-86 **Hui Xue*** (huixue@clemson.edu), Department of Mathematical Sciences, Clemson University, Clemson, SC 29634. *The derivative of certain Eisenstein series.*

We first construct an incoherent Eisenstein series which is naturally attached an imaginary quadratic field. We then study the derivative of the Eisenstein series at the center of symmetry, and show that its Fourier coefficients are related to arithmetic degrees of certain zero cycles. (Received July 27, 2011)

1073-11-95 **Riad Masri***, Department of Mathematics, Mailstop 3368, Texas A&M University, College Station, TX 77843-3368. *The asymptotic distribution of traces of cycle integrals of the j-function.*

Cycle integrals of the classical modular j-function can be viewed as real quadratic analogs of singular moduli. Recently, Duke, Imamoglu, and Toth proved that the generating function for traces of these cycle integrals is a mock modular form of weight $1/2$ for $\Gamma_0(4)$. They also established an exact formula for these traces, and made a conjecture concerning their asymptotic distribution. In this talk I will discuss a proof of this conjecture. A key role is played by the equidistribution of integral points on 1-sheeted hyperboloids, which is used to establish cancellation in Weyl sums for quadratic roots. (Received July 28, 2011)

1073-11-112 **Jeff Beyerl*** (jbeyerl@clemson.edu), **Kevin James** and **Hui Xue**. *Divisibility of an Eigenform by another Eigenform.*

We prove a consequence of Maeda's conjecture that an eigenform is a factor of a cuspidal eigenform only when it is forced to be for dimension consideration. A similar result for Eisenstein series is also shown. We then relate the factorization of eigenforms to linear independence of Rankin-Selberg L-values. (Received July 29, 2011)

1073-11-113 **Catherine M Trentacoste*** (trentac@clemson.edu), **Kevin James**, **Hui Xue**, **Kelly Crone-Dye**, **Tony Feng**, **Carolyn Kim** and **Eric Ramos**. *Sizes of 3-Selmer Groups.* Preliminary report.

In this talk we will consider a specific family of elliptic curves with rational 3-torsion subgroup. We will algebraically define 3-Selmer groups through 3-isogeny and a 3-descent map, then associate the image of our 3-descent map to solutions of a homogeneous polynomial affiliated with our elliptic curve E. Using the work of Cohen and Pazuki, we will give solubility conditions for the homogeneous polynomials. Using these conditions, we will give a graphical approach to the size of 3-Selmer groups. Finally, we will demonstrate how to change the conditions on graphs into a question about ranks of matrices. (Received July 31, 2011)

1073-11-134 **Chad Awtrey*** (cawtrey@elon.edu). *Computational Galois theory for p-adic fields.*

An important problem in constructive local class field theory is the computation of arithmetic invariants of p-adic fields. Of particular interest is the determining of Galois groups of such fields. In light of recent results, we discuss the traditional method for computing Galois groups (resolvents) as well as newer methods (based on subfields). (Received July 30, 2011)

1073-11-138 **Michael Dewar*** (mdewar@mast.queensu.ca). *The image and kernel of Atkin's U_p operator modulo p.*

We determine the precise image of Atkin's U_p operator acting on reduced modular forms. The result holds for any level coprime to p. In particular, we determine the dimension of the kernel of U_p at weights $k > p + 1$. This contrasts with the low-weight case in which the dimension of the kernel is still very mysterious and erratic. (Received July 30, 2011)

1073-11-168 **John J Webb*** (webbjj@wfu.edu), PO Box 7388, 127 Manchester Hall, Winston-Salem, NC 27109. *The zoom rate of F-K-O partition congruences.*

In recent work, Folsom, Kent, and Ono show that for primes ≥ 5, values of the partition function are ℓ-adically self-similar. This arises from the fact that under alternate iteration of certain operators, the generating function for $p(n) \pmod{\ell^m}$ eventually lands in a finite-rank submodule which is stable under these operators. We improve the bound on the number of iterations (the "zoom rate") required for this process to stabilize. Calculations show that this bound is sharp for small ℓ and m. This is joint work with Matthew Boylan. (Received July 31, 2011)

1073-11-191 **Jenny G. Fuselier*** (jfuselie@highpoint.edu). *An update on the traces of Hecke operators in level 1 and Gaussian hypergeometric functions.* Preliminary report.

In this talk, we explore some extensions of recent work relating traces of p^{th} Hecke operators in level 1, traces of Frobenius of families of elliptic curves, and values of finite field hypergeometric functions. My previous results carried the restriction $p \equiv 1 \pmod{12}$. Earlier this year, Lennon removed this restriction to prove a formula relating values of a ${}_2F_1$ function over $\mathbb{F}_q$ to traces of Frobenius of families of elliptic curves over $\mathbb{F}_q$, where $q = p^e$

and $q \equiv 1 \pmod{12}$. In this talk, we provide a general formula for the traces of p^{th} Hecke operators in level 1 (for all $p > 3$) in terms of the trace of Frobenius of a family of elliptic curves over $\mathbb{F}_p$. Then, we combine this result with Lennon's work to produce formulas for traces of p^{th} Hecke operators in level 1 in terms of hypergeometric functions over $\mathbb{F}_{p^2}$. (Received August 01, 2011)

1073-11-202 **Paul Jenkins*** (jenkins@math.byu.edu) and **Jeremy Rouse**. *Bounds for coefficients of cusp forms and extremal lattices.*

A cusp form $f(z)$ of weight k for $\mathrm{SL}_2(\mathbb{Z})$ is determined uniquely by its first $\ell := \dim S_k$ Fourier coefficients. We derive an explicit bound on the nth coefficient of f in terms of its first ℓ coefficients. We use this result to study the non-negativity of the coefficients of the unique modular form of weight k with Fourier expansion

$$F_{k,0}(z) = 1 + O(q^{\ell+1}).$$

In particular, we show that $k = 81632$ is the largest weight for which all the coefficients of $F_{k,0}(z)$ are non-negative. This result has applications to the theory of extremal lattices. This is joint work with Jeremy Rouse. (Received August 01, 2011)

1073-11-232 **Jim Brown*** (jimlb@clemson.edu). *Eisenstein series on GU(3,3) and non-trivial torsion in Shafarevich-Tate groups.*

Applications of recent work of Pitale-Saha-Schmidt on a pullback formula from GU(3,3) to GSp(4) x GL(2) will be discussed. In particular, we will outline how one can use this formula to give a lower bound on a particular twist of a Shafarevich-Tate group attached to a two dimensional modular Galois representation. (Received August 02, 2011)

1073-11-240 **Ben Brubaker*** (brubaker@math.mit.edu), 11 Gardner Rd. - Unit 2, Cambridge, MA 02139. *Hypergeometric functions, elliptic curves and modular forms.* Preliminary report.

I'll discuss ongoing work with Catherine Lennon on the appearance of special functions – finite field analogs of hypergeometric functions – in both the L-functions of elliptic curves and modular forms and their relation to work of N. Katz and conjectures of F. Rodriguez-Villegas. (Received August 02, 2011)

1073-11-244 **Nathan C. Jones***, Mathematics Dept, University of Mississippi, Hume Hall 305, P.O. Box 1848, University, MS 38677. *The Lang-Trotter conjecture for Frobenius fields.*

Let E be an elliptic curve defined over Q. For each prime p of good reduction for E, consider the quadratic extension K(p) obtained by adjoining to Q the roots of the p-th Frobenius polynomial. In 1976, S. Lang and H. Trotter predicted a precise asymptotic formula for the number of primes p up to X for which K(p) is equal to a fixed imaginary quadratic field. In this talk, I will discuss recent joint work with A.C. Cojocaru and H. Iwaniec, in which we prove that the Lang-Trotter Conjecture holds "on average" over families of elliptic curves. (Received August 02, 2011)

1073-11-254 **Kathrin Bringmann** and **Zachary A Kent*** (kent@mathcs.emory.edu), Dept. of Math & CS, 400 Dowman Drive, W404, Atlanta, GA 30322. *L-series and L-values for weakly holomorphic modular forms.*

We explore a method for associating L-series to weakly holomorphic modular forms (those modular forms with possible poles supported at cusps), and then proceed to study their L-values. Critical L-values are shown to fit nicely within the framework of period polynomials and an extended Eichler-Shimura theory recently studied by Bringmann, Guerzhoy, Kent, and Ono. A generating series for non-critical L-values is then interpreted as a mock period function, extending recent work of Bringmann, Diamantis, and Raum. Finally, we prove a curious limiting theorem which relates transcendental periods of a mock modular form and its shadow to the ratio of their non-critical L-values. (Received August 02, 2011)

1073-11-257 **Frank Thorne*** (thornef@mailbox.sc.edu). *Secondary terms in counting functions for cubic fields.*

The classical Davenport-Heilbronn theorem states that the number of cubic fields K with $0 < |\mathrm{Disc}(K)| < X$ is asymptotic to $\frac{1}{3\zeta(3)}X$. However, subsequent computations revealed the theorem to be a poor match to the data. Based on these, Roberts conjectured the existence of a secondary term of order $X^{5/6}$.

We will discuss our proof of Roberts' conjecture using the analytic theory of Shintani zeta functions. Our work is independent of another proof of the conjecture by Bhargava, Shankar, and Tsimerman using different methods. We will also discuss a variety of generalizations of our results, in particular to arithmetic progressions where a curious bias appears in the secondary term.

All of this is joint with Takashi Taniguchi, and some of the more recent work is also joint with Manjul Bhargava. (Received August 02, 2011)

1073-11-262 **Seyfi Turkelli*** (turkelli@math.uga.edu). *Cubic fields with prime discriminant.*
In this talk, we will discuss recent work on cubic fields with prime discriminant. (Received August 03, 2011)

13 ► Commutative rings and algebras

1073-13-67 **Nan Li*** (nan@math.mit.edu) and **Amos Ron**. *External zonotopal algebra.*
We provide a general, unified, framework for external zonotopal algebra. The approach is critically based on employing simultaneously the two dual algebraic constructs, known as the P space and the D space, and invokes the underlying matroidal and geometric structures in an essential way. (Received July 26, 2011)

1073-13-90 **Juan C. Migliore*** (migliore.1@nd.edu), Dept of Mathematics, University of Notre Dame, Notre Dame, IN 46556. *Unimodality (or not) of pure O-sequences.*
A pure O-sequence is the vector counting the monomials, in each degree, of a pure monomial order ideal. Alternatively, it is the Hilbert function of a level artinian monomial algebra. These arise in many different contexts. It has long been known that pure O-sequences are not necessarily unimodal. However, on one hand we can ask "how non-unimodal can they be," and on the other hand we can ask for situations where they *are* necessarily unimodal. In this talk we present results of both types, and give some idea about the proofs. Some results are due to Boij, Migliore, Miró-Roig, Nagel and Zanello, while others are due to Bernadette Boyle. (Received July 27, 2011)

1073-13-203 **David Cook II** and **Uwe Nagel*** (uwe.nagel@uky.edu), Department of Mathematics, University of Kentucky, 715 Patterson Office Tower, Lexington, KY 40506-0027. *Enumerations deciding the weak Lefschetz property.*
We introduce a natural correspondence between artinian monomial almost complete intersections in three variables and punctured hexagonal regions. We use this correspondence to investigate the algebras for the presence of the weak Lefschetz property. In particular, we relate the field characteristics in which such an algebra fails to have the weak Lefschetz property to the prime divisors of the enumeration of signed lozenge tilings of the associated punctured hexagonal region. On the one side this allows us to establish the weak Lefschetz property in many new cases. On the other side, we can determine some of the prime divisors of the enumerations by means of an algebraic argument. (Received August 01, 2011)

1073-13-217 **Christine Berkesch** and **Daniel Erman*** (erman@umich.edu), Department of Mathematics, East Hall, Ann Arbor, MI 48109, and **Manoj Kummini** and **Steven Sam**. *Tensor Complexes.*
The most fundamental complexes of free modules over a commutative ring are the Koszul complex, which is constructed from a vector (i.e., a 1-tensor), and the Eagon–Northcott complex, which is constructed from a matrix (i.e., a 2-tensor). I will discuss a multilinear generalization of these complexes, which we construct from an arbitrary higher tensor. Our construction provides detailed new examples of minimal free resolutions, as well as a unifying view on previously studied classes of examples, including the above examples, hyperdeterminantal complexes, and more. (Received August 01, 2011)

1073-13-237 **J. Brett Barwick*** (barwicjb@mailbox.sc.edu). *Generic Hilbert-Burch matrices of ideals generated by triples of homogeneous forms in $k[x, y]$.* Preliminary report.
Consider the set of triples of homogeneous degree d forms $\boldsymbol{g} = (g_1, g_2, g_3)$ in $R = k[x, y]$, with k a field, so that the ideal I generated by the g_i's has height 2. This set naturally corresponds to an affine space of dimension $3d + 3$ over k by identifying each triple $\boldsymbol{g}$ with a list of its coefficients. The Hilbert-Burch Theorem describes the graded minimal free resolution of R/I, which has the form

$$0 \to \begin{matrix} R(-d-m) \\ \bigoplus \\ R(-d-n) \end{matrix} \xrightarrow{\varphi} R(-d)^3 \to R \to R/I \to 0$$

where the entries in the columns of a matrix representing φ are homogeneous forms in R of degrees m and n with $m + n = d$. We refer to such a matrix as a Hilbert-Burch matrix for I. Recent work of Cox-Kustin-Polini-Ulrich considers this set in the case when d is even and $m = n = d/2$, and identifies an open cover $\{U_i\}$ of $\mathbb{A}_k^{3d+3}$ such that on each U_i the coefficients of the entries of a Hilbert-Burch matrix for I can be recovered explicitly

as polynomials in the coefficients of the g_i's. We describe an extension of this work to all integers $d \geq 2$ and all $1 \leq m \leq n \leq d$ with $m + n = d$. (Received August 02, 2011)

14 ► Algebraic geometry

1073-14-2 **Allen Knutson*** (allenk@math.cornell.edu). *Modern developments in Schubert calculus.*
How many k-planes in n-space are there satisfying a list of (sufficiently generic) intersection conditions? This is a product calculation in the cohomology ring of a Grassmannian. One might say that (e.g.) the number of red lines in projective 3-space that touch four generic blue lines is *topologically* constrained to be 2.

This has many generalizations, e.g. replacing "k-planes V" by "isotropic k-planes" or "chains $(V_1 < V_2 < ...)$ of subspaces"; replacing cohomology by e.g. K-theory or quantum cohomology; or any combination. The multiplication's coefficients no longer have such simple geometric interpretations, but in each case, *algebraic geometry* shows that they are nonnegative.

For many purposes (e.g. applications to control theory), one is only interested in whether some k-plane can be found at all. So one wants rules for these numbers that are not alternating sums but manifestly positive, and *algebraic combinatorics* enters the fray.

I'll focus on one rule (of many known) that Terry Tao, Chris Woodward, and I found useful for constraining sums of Hermitian matrices. This "puzzle" rule has a very direct connection to the algebraic geometry, and (by adding puzzle pieces) extensions to several of the generalizations. (Received August 01, 2011)

1073-14-108 **June Huh*** (junehuh@umich.edu). *Correspondences between $\mathbb{P}^n$ and log-concave sequences in combinatorics.*
Correspondences between $\mathbb{P}^n$ are one of the very first topics in algebraic geometry. In modern language, a correspondence between $\mathbb{P}^n$ is an integral homology class of $\mathbb{P}^n \times \mathbb{P}^n$ corresponding to a subvariety. We discuss numerical characterization of correspondences between $\mathbb{P}^n$ and their relation to log-concave sequences in combinatorics. (Received July 29, 2011)

1073-14-130 **Erik Insko** (erik-insko@uiowa.edu), Department of Mathematics, B20E MacLean Hall, Iowa City, IA 52242-1419, and **Alexander Yong*** (ayong@uiuc.edu), 1409 W. Green Street, Urbana, IL 61801. *Patch ideals and Peterson varieties.*
Patch ideals encode neighbourhoods of a variety in GL_n/B. For Peterson varieties we determine generators for these ideals and show they are complete intersections, and thus Cohen-Macaulay and Gorenstein. Consequently, we

- combinatorially describe the singular locus of the Peterson variety;
- give an explicit equivariant K-theory localization formula; and
- extend some results of [B. Kostant '96] and of D. Peterson to intersections of Peterson varieties with Schubert varieties.

We conjecture that the tangent cones are Cohen-Macaulay, and that their h-polynomials are nonnegative and upper-semicontinuous. (Received July 30, 2011)

1073-14-151 **Leonardo C Mihalcea*** (lmihalce@vt.edu), 460 McBride Hall, Dept. of Mathematics, Virginia Tech University, Blacksburg, VA 24061, and **Changzheng Li** (czli@kias.re.kr), School of Mathematics, Korea Institute for Advanced Study, Seoul, South Korea. *Gromov-Witten invariants for lines in flag manifolds.*
We will present a method to calculate generalized Gromov-Witten invariants for classes of lines in flag manifolds. Furthermore, we will study various relations among these invariants. This is joint work with Changzheng Li. (Received July 31, 2011)

1073-14-164 **Christine Berkesch***, Mathematics Department, Duke University, Box 90320, Durham, NC 27708, and **Laura Felicia Matusevich**. *Classical and equivariant hypergeometric D-modules.*
The solutions of classical Horn systems of differential equations, including the Gauss and Appell–Lauricella hypergeometric equations, are among the most studied functions in mathematics. After applying a change of variables that gives an isomorphism of solution spaces, Horn systems are transformed into torus-equivariant systems, and the combinatorial tools of toric geometry have provided descriptions of important D-module theoretic properties of these new systems. While this change of variables does not induce an isomorphism at the level of differential equations, we establish a quotient relationship between Horn systems and their equivariant

counterparts that opens the door for passage of these D-module theoretic properties to the classical setting. (Received July 31, 2011)

1073-14-243 **Richard Rimanyi*** (rimanyi@email.unc.edu), Department of Mathematics, CB#3250 Phillips Hall, UNC, Chapel Hill, NC 27599. *Generating functions for quiver polynomials.* Preliminary report.

Degenerations of quivers can be measured by certain polynomials. We will show an iterated residue form of these polynomials (in the A, D, E case), which reveals various stabilization and positivity properties. (Received August 02, 2011)

1073-14-263 **Anders Nedergaard Jensen** (jensen@math.uni-sb.de), University of Saarlandes, and **Josephine Yu*** (josephine.yu@math.gatech.edu), Georgia Tech. *Computing Tropical Resultants*

Tropical resultant varieties arise when fixing a set of supports of polynomials and asking for which set of coefficients their tropical hypersurfaces have a common intersection. These coincide with the tropicalization of sparse resultant varieties. In this talk we describe tropical resultants combinatorially and compare various methods for computing them. Some of the algorithms involve traversing subfans of secondary fans while other works by reconstruction tropical hypersurfaces from projections. (Received August 04, 2011)

16 ► Associative rings and algebras

1073-16-18 **Miodrag Cristian Iovanov*** (yovanov@gmail.com), Los Angeles, CA 90089. *Serial (co)algebras, infinite abelian groups, and a class of quantum groups.*

The classical theory of serial rings is well known; such rings have the property that any f.p. module is a direct sum of indecomposable serial modules, and if the ring is artinian (e.g. a f.d. algebra), every module decomposes as such. It is natural to ask the question of when such decompositions hold for the category of all finite dimensional representations of an algebra, or all rational representations, or, more generally, in a linear locally f.g. category. Equivalently, this turns into the study of the serial coalgebras and their comodules. We show how techniques from the theory of Infinite Abelian Groups can be generalized to the case of such "serial locally finitely generated categories". Using extensions of basic and serving subgroups, height, depth etc. we can prove, for example, analogues of Prufer theorems or Kulikov's criterion, and show when every (f.d.) comodule is as a direct sum of uniserials, or of indecomposables. In particular, we also answer a few general open questions. We also classify coserial pointed Hopf algebras; they include interesting examples of quantum groups, such as quantum SL2 (or Uq(sl2)). Part of these also occur from another combinatorial perspective: Hopf algebras having non-zero integral and with a basis of paths in a quiver (co)algebra. (Received June 7, 2011)

1073-16-19 **Gangyong Lee**, **S. Tariq Rizvi** and **Cosmin Roman*** (cosmin@math.ohio-state.edu), Department of Mathematics, Galvin Hall 4th, 4240 Campus Dr., Lima, OH 45804. *Indecomposable endoregular modules.*

It is well-known that a ring R is von Neumann regular iff for any $a \in R$, there exists $b \in R$ such that $a = aba$.

We recently studied and introduced the notion of an *endoregular module*, one endowed with the properties of both Rickart modules and dual Rickart modules. Let R be a ring. An R-module M is called endoregular if both the kernel and the image of any endomorphism of M are direct summands in M (M is a *Rickart module* if for all $\varphi \in End_R(M)$, $Ker\varphi \leq^{\oplus} M$, and dually, M is called a *dual Rickart module* if $Im\varphi \leq^{\oplus} M$ for all $\varphi \in End_R(M)$). We noted that a module whose endomorphism ring is von Neumann regular turns out to be precisely an endoregular module, thus confirming that the latter are module-theoretic generalizations of regular rings.

In this talk we will discuss properties of endoregular modules, with a view toward insights in the related properties of regular rings. In particular, we will present results and examples concerning direct decompositions as well as indecomposable endoregular modules.

(This is a joint work with S. Tariq Rizvi and Gangyong Lee.)
(Received June 7, 2011)

1073-16-21 **Kiyoshi Igusa*** (igusa@brandeis.edu), Mathematics Department, Brandeis University, Waltham, MA 02453, **Shiping Liu** (shiping.liu@usherbrooke.ca), Département de Mathématiques, Université de Sherbrooke, Sherbrooke, Québec J1K 2R1, and **Charles Paquette** (charles.paquette@usherbrooke.ca), Département de Mathématiques, Université de Sherbrooke, Sherbrooke, Québec J1K 2R1. *A proof of the strong no loop conjecture.*

Given a quiver with relations, the strong no loop conjecture states that, if the quiver has a loop at a vertex, the simple module at the vertex has infinite projective dimension. This has been shown in several cases. We give a proof of this conjecture in general using a localized trace function for endomorphisms of modules. We also obtain several extensions and generalizations. (Received June 24, 2011)

1073-16-25 **Tom Cassidy*** (tcassidy@bucknell.edu) and **Chris Phan**. *Graded algebras with relations in degrees 2 and d.* Preliminary report.

Finitely generated graded algebras with defining relations in degrees 2 and d can have Koszul-like homological properties. Such algebras have been independently studied by Vatne and by Green and Marcos. I will discuss connections between these two approaches, and answer two questions posed by Green and Marcos. I will also provide a partial answer to a question posed by Vatne. This is joint work with Chris Phan. (Received July 02, 2011)

1073-16-37 **Chelsea Walton*** (chelsea.notlaw@gmail.com), University of Washington, 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. (Received July 18, 2011)

1073-16-38 **Manuel L. Reyes*** (manuel.l.reyes@gmail.com), Department of Mathematics, Bowdoin College, 8600 College Station, Brunswick, ME 04011-8486. *Obstructing extensions of the functor Spec to noncommutative rings.*

We will present the following obstruction result for functors extending the Zariski spectrum to noncommutative rings: every contravariant functor from the category of rings to the category of sets whose restriction to the full subcategory of commutative rings is isomorphic to Spec must assign the empty set to $\mathbb{M}_n(\mathbb{C})$ for $n \geq 3$. The proof relies on the Kochen-Specker "no-hidden-variables" theorem of quantum mechanics. We will also mention a recent generalization of the result due to van den Berg and Heunen. (Received July 18, 2011)

1073-16-42 **Pete Goetz*** (pdg11@humboldt.edu). *The Cohomology of the "Group Of Loops", Preliminary Report.*

In this talk I will discuss a group that can be studied from the point of view of combinatorial group theory, topology, and algebra. Fix a positive integer n and let G be the group with generators a_{ij}, $1 \leq i \neq j \leq n$ and relations

$$[a_{ij}, a_{kj}], \quad [a_{ij}, a_{ik}a_{jk}], \quad [a_{ij}, a_{kl}]$$

where i, j, k, l are distinct and $[x, y]$ denotes the group commutator. This group has many manifestations and I will begin by discussing some areas (combinatorial group theory, topology) in which it arises. In 1993, Brownstein and Lee conjectured a presentation for the rational cohomology algebra, $H^*(G, \mathbb{Q})$. Jensen, McCammond, and Meier proved the conjecture in 2006. In the second part of my talk, I will discuss some progress of myself and Andrew Conner on proving the Koszulity of the algebra $H^*(G, \mathbb{Q})$. An exciting recent development is that $H^*(G, \mathbb{Q})$ is a quotient of the enveloping algebra of a certain Lie algebra related to the Yang-Baxter equation defined by Bartholdi, Enriquez, Etingoff, and Rains. (Received July 19, 2011)

1073-16-60 **Calin I Chindris*** (chindrisc@missouri.edu). *Exceptional sequences in module categories.*

I will explain how orthogonal exceptional sequences of modules can be used to study the geometry of modules for finite-dimensional algebras. In particular, I will discuss the rationality problem for tame algebras, and the unirationality of orbit closures in module varieties. (Received July 25, 2011)

1073-16-70 **Justin Allman*** (jallman@live.unc.edu). *A quantum analogue of the dihedral action on Grassmannians.*

By choosing an appropriate co-cycle twisting of the quantum Grassmannian $\mathcal{O}_q(G(m,n))$, S. Launois and T.H. Lenagan have recently shown how to construct an isomorphism which, on quantum minors, has the effect of permuting indices by the cycle $c = (12\dots n)$. In this talk, I describe how (in joint work with Jan E. Grabowski) we extend their method to construct a family of isomorphisms of the quantum Grassmannian with other twisted algebras. Together, these can be viewed as a quantum analogue of an action on minors by the full dihedral subgroup of S_n generated by c and the longest element ω_0. Such an action is known to exist in the semi-classical setting (by Poisson automorphisms and anti-automorphisms, a result of Yakimov), and for both the totally non-negative and totally positive Grassmannians. For certain specific values of m and n a dihedral action is already known to play a role in a quantum cluster algebra structure. (Received July 26, 2011)

1073-16-71 **Edward L Green*** (green@math.vt.edu), Department of Mathematics, 460 McBryde Hall, Blacksburg, VA 24060, **Sybille Schroll**, Department of Mathematics, University of Leicester, University Road, Leicester, LE1 7RH, England, and **Nicole Snashall**, Department of Mathematics, University of Leicester, University Road, Leicester, LE1 7 RH, England. *Group gradings and actions on Brauer graph algebras.* Preliminary report.

I will introduce the theories of Brauer gradings and Brauer actions by finite abelian groups on Brauer graph algebras. I will also give some applications. (Received July 27, 2011)

1073-16-103 **Andrew Conner*** (connerab@wfu.edu) and **Brad Shelton**. *$\mathcal{K}_2$ factors of Koszul algebras and the $\mathcal{K}_2$ property for face rings.*

Relatively little seems to be known about the structure of a face ring's Yoneda Ext-algebra beyond Fröberg's theorem that all quadratic face rings are Koszul algebras. Cassidy and Shelton recently introduced the notion of $\mathcal{K}_2$ algebra as an analog of the Koszul property for graded algebras with defining relations of more than one homogeneous degree. The study of $\mathcal{K}_2$ algebras, continued in this paper, removes the major obstacle of homological purity from proving Koszul-type structural results for non-quadratic face rings. We extend a change-of-rings theorem for Koszul algebras due to Backelin and Fröberg and use it to show some important families of non-quadratic face rings are $\mathcal{K}_2$. (Received July 28, 2011)

1073-16-132 **Ryan Kinser*** (kinser@gmail.com). *Tree modules and counting polynomials for free algebras.* Preliminary report.

A tree module for a (finitely generated, associative) free algebra is one whose structure can be presented by a tree graph with directed, labeled edges. (One may also think of it as a quiver representation.) We present some tools for determining whether such a module is indecomposable based on the structure of the graph, and for determining when two such modules are isomorphic.

These are applied to count isomorphism classes of tree modules for small dimension $d \leq 5$. It turns out that the number of isoclasses is a polynomial in the number of generators g of the algebra. Furthermore, these are the same polynomials obtained by Rodriguez Villegas and Helleloid when counting certain representations of the same algebra over the finite field with q elements, then evaluating at $q = 1$.

We speculate on an extension of these observations to all quivers and dimension vectors, and possible relations to a conjecture of Kac on cell decompositions of moduli spaces of quiver representations. (Received July 30, 2011)

1073-16-152 **Padmini Veerapen*** (pveerapen@uta.edu), TX , and **Michaela Vancliff** (vancliff@uta.edu). *A Notion of Rank for Noncommutative Quadratic Forms.* Preliminary report.

To every (commutative) quadratic form is associated a symmetric matrix, and one has the standard notions of rank and determinant function defined on the matrix, and, thus, on the quadratic form. In a recent paper by T. Cassidy & M. Vancliff, the notion of quadratic form is extended to the noncommutative setting. In this talk, we will see that a notion of rank (μ-rank) may be defined on such noncommutative quadratic forms. We use our definition of μ-rank of a noncommutative quadratic form to establish a connection between the points in the zero locus of the relations of a graded skew Clifford algebra A and quadratic forms of μ-rank at most two associated to A. (Received July 31, 2011)

1073-16-156 **Hans Erik Nordstrom*** (nordstro@up.edu), Department of Mathematics, University of Portland, 5000 N Willamette BLVD, Portland, OR 97203. *Leavitt path algebras over arbitrary unital rings.* Preliminary report.

Leavitt path algebras over fields provide purely algebraic analogs to graph C^* algebras. Significant theorems in the study of graph C^* algebras have parallels in the context of Leavitt path algebras. For example, the conditions on a graph for determining the simplicity of a graph C^* algebra are identical to those for a Leavitt path algebra over a field. We discuss some straightforward results on the simplicity of Leavitt path algebras over arbitrary unital rings and their tensors. We consider results regarding the prime spectrum of Leavitt path algebras over fields, and the prospect of extending those results, as well as other methods for computing the propagation of prime ideals, using the data from the base ring, R. (Received July 31, 2011)

1073-16-157 **Manizheh Nafari*** (manizheh@uta.edu), Dept of Mathematics, University of Texas at Arlington, P.O.Box 19408, Arlington, TX 76019. *Regular Algebras Related to Regular Graded Skew Clifford Algebras of Low Global Dimension.*

M. Artin, W. Schelter, J. Tate, and M. Van den Bergh introduced the notion of non-commutative regular algebras, and classified regular algebras of global dimension 3 on degree-one generators by using geometry (i.e., point schemes) in the late 1980s. Recently, T. Cassidy and M. Vancliff generalized the notion of a graded Clifford algebra and called it a graded skew Clifford algebra.

In this talk, we prove that all classes of quadratic regular algebras of global dimension 3 contain graded skew Clifford algebras or Ore extensions of graded skew Clifford algebras of global dimension 2. We also show that a certain subalgebra R of a regular graded skew Clifford algebra A is a twist of the polynomial ring if A is a twist of a regular graded Clifford algebra B. We have an example that demonstrates that this can fail when A is not a twist of B.

(Received July 31, 2011)

1073-16-177 **Frauke M. Bleher***, University of Iowa, Department of Mathematics, Iowa City, IA 52242. *Richard Brauer's work and universal deformation rings.* Preliminary report.

In this talk, I will show how Richard Brauer's work on 2-modular blocks of finite groups of tame representation type can be used to compute the universal deformation rings of certain modules belonging to such blocks. I will concentrate on modules whose endomorphism rings are given by scalars and their syzygies. When determining the universal deformation rings of these modules, it turns out that one needs both the modular representation theory of the block under consideration and the values on 2-singular elements of the ordinary irreducible characters belonging to this block.

If the block is principal, Brauer showed that there is very little fusion. This results in very nice formulas for character values on 2-singular elements. However, if the block is not principal, fusion can be much less controlled. One then has to use Brauer's generalized decomposition numbers. These lie in the ring of integers of an appropriate cyclotomic field of 2-power order. (Received August 01, 2011)

1073-16-212 **Kiyoshi Igusa** (igusa@brandeis.edu), Brandeis University, Waltham, MA 02453, and **Gordana G. Todorov*** (g.todorov@neu.edu), Northeastern University, Boston, MA 02115. *Properties of Continuous Cluster Categories.*

We define a family of categories $C^{(c,d)}$ for $c, d \in \mathbf{R}_+$.

In Thm1 we give a precise statement for which $c, d \in \mathbf{R}_+$ the categories $C^{(c,d)}$ are general cluster categories. In Prop2 we state that these categories satisfy certain continuous condition, giving justification to the name. Thm3 gives relations between spaced out cluster categories, classical cluster categories of type A_n and continuous cluster categories.

Theorem 1 The categories $C^{(c,d)}$ are general cluster categories if and only if either $c = d$ or $c < d$ and $2d/(d-c)$ is an integer greater than 3.

Proposition 2 All automorphisms of $C^{(c,d)}$ are continuous with respect to the naturally induced topology from $\mathbf{R^2}$ to $C^{(c,d)}$.

Theorem 3 a) For each spaced out cluster category S_n there is a triangulated embedding $S_n \to C^{(c,c)}$.

b) For each classical cluster category C_{A_n} there is a triangulated embedding $C_{A_n} \to C^{(c,d)}$ providing that $2d/(d-c) = n+3$. (Received August 01, 2011)

1073-16-224 **Christopher Lee Phan*** (clp020@bucknell.edu), Department of Mathematics, Bucknell University, Lewisburg, PA 17837. *Delayed Koszul duality.* Preliminary report.

A well-known result states that the Yoneda algebra $E(A) = Ext_A(k, k)$ of a Koszul algebra A is another quadratic algebra, which is again Koszul; indeed, $E(E(A)) \simeq A$. Green, et. al., have also proven a similar property for Berger's class of N-Koszul algebras: if A is N-Koszul, then $E(E(E(A))) \simeq E(A)$. We study the condition $E(E(E(A))) \simeq E(A)$ in general. (Received August 02, 2011)

1073-16-238 **Markus Schmidmeier*** (markusschmidmeier@gmail.com). *How Homomorphisms Factor Through Auslander-Reiten Components.*

Given a homomorphism between modules over a finite dimensional algebra, and a connected component of the Auslander-Reiten quiver, we ask through which objects in the component the homomorphism factors.

In this talk we visualize in several cases of finite, tame and wild representation type, how certain particularly simple maps in the category of invariant subspaces of nilpotent linear operators factor through Auslander-Reiten components.

Our methods include tableaux for the description of modules, knowledge about the Auslander-Reiten translation, and a modified version of the Snake Lemma. (Received August 02, 2011)

17 ► Nonassociative rings and algebras

1073-17-196 **Peter Tingley*** (ptingley@math.mit.edu) and **Anne Schilling**. *Demazure crystals, Kirillov-Reshetikhin crystals, and the energy function.*

I will discuss a paper with Anne Schilling which surveys and expands upon some relationships between Demazure crystals of non-exceptional affine Kac-Moody algebras and Kirillov-Reshetikhin (KR) crystals. In particular, certain Demazure crystals are isomorphic as classical crystals to tensor products of KR crystals, and we show that this isomorphism intertwines the natural affine grading on the Demazure crystals with a combinatorially defined energy function. This leads to a formula for the Demazure character in terms of the energy function, and has applications to symmetric function theory since certain specializations of Macdonald polynomials are equal to specializations of Demazure characters. I will not assume much familiarity with crystals, but when I get to applications I will assume the audience is familiar with Macdonald polynomials. (Received August 01, 2011)

1073-17-264 **Anthony Giaquinto*** (tonyg@math.luc.edu), Loyola University Chicago. *Meander graphs and Frobenius Seaweed Lie algebras*

The index of a seaweed Lie algebra can be computed from its associated meander graph. We examine this graph in several ways with a goal of determining families of Frobenius (index zero) seaweed algebras. Our analysis gives two new families of Frobenius seaweed algebras as well as elementary proofs of known families of such Lie algebras. (Received August 04, 2011)

22 ► Topological groups, Lie groups

1073-22-223 **Alexandru G Atim*** (atima@benedict.edu), 1600 Harden St., Columbia, SC 29204, and **Robert R Kallman**, 1155 Union Circle #311430, Denton, TX 76203. *A Property of Isometry Groups of a Hilbert Space.*

Let G be a Polish group. G is said to be an algebraically determined Polish group if for any Polish group H and any algebraic isomorphism $\varphi : H \to G$ we have that φ is a topological isomorphism. Let $\mathcal{H}$ be a separable complex Hilbert space and $\mathcal{U}(\mathcal{H})$ be the group of unitary operators acting on $\mathcal{H}$. The purpose of this paper is to prove that the complex isometry group of $\mathcal{H}$, $\mathcal{H} \rtimes \mathcal{U}(\mathcal{H})$ is algebraically determined Polish group. Similar results hold for most (but not all) of the finite dimensional complex isometry groups and for their real Hilbert space analogues. (Received August 01, 2011)

30 ► Functions of a complex variable

1073-30-82 **Rob Kusner*** (kusner@math.umass.edu), G.A.N.G. & Mathematics, University of Massachusetts, Amherst, MA 01003. *Knots and Links as Conformal Bands.* Preliminary report.

Knots and links can be realized as collections of annular bands immersed in the plane arising from limits of embedded bands in three-space. One hope for this band model was to estimate the ropelength of knots and links

in terms of a more easily computed analogue called bandlength; another hope was to provide a simpler setting to study constrained criticality. While progress has been made verifying earlier results and conjectures about bandlength, recent attention has turned to a conformally-invariant version defined via the extremal length (or, reciprocally, the conformal modulus) of conformally immersed annular bands in $\mathbf{C} \cup \infty = \mathbf{CP^1} = \mathbf{S^2}$. This talk will discuss some of the subtleties involved in defining, computing and optimizing conformal bandlength. (Received July 27, 2011)

33 ► Special functions

1073-33-10 **Daniel Orr*** (danorr@live.unc.edu), University of North Carolina at Chapel Hill, Department of Mathematics, CB #3250, Chapel Hill, NC 27599. *q-Hermite polynomials, nil-DAHA, and q-Whittaker functions.*

We will consider the Macdonald polynomials in the limit at $t = 0$ and the corresponding limit of the double affine Hecke algebra (DAHA), leading to the so-called nil-DAHA. In order to keep things as explicit as possible, we will concentrate on the rank-one case. In this setting, the symmetric Macdonald polynomials are identified with a q-analogue of the Hermite polynomials. We will explain how the theory of DAHA leads to q-Whittaker functions expressed in terms of Macdonald polynomials at $t = 0$. (Received May 31, 2011)

1073-33-172 **Siddhartha Sahi*** (sahi@math.utgers.edu), Mathematics Department, Rutgers University, New Brunswick, NJ 08903. *Littlewood-Richardson coefficients for Macdonald polynomials.*

We give a formula for computing the expansion of a product of two Macdonald polynomials as a linear combination of Macdonald polynomials. Our procedure also works for non-symmetric polynomials and interpolation polynomials. (Received August 01, 2011)

34 ► Ordinary differential equations

1073-34-53 **Abdulmalik Al Twaty** and **Paul Eloe*** (paul.eloe@notes.udayton.edu). *The Role of Concavity in Applications of Functional Fixed Point Theorems to Higher Order Differential Equations.*

In this article we apply an extension of an Avery type functional fixed point theorem to a family of boundary value problems for higher order ordinary differential equations. The theorem employs concave and convex functionals defined on a cone in a Banach space. Concavity of differentiable functions plays a key role in the application to second order equations. It is shown that a concept of generalized concavity plays the same key role in the application to the higher order equation. (Received July 22, 2011)

1073-34-123 **Kale Oyedeji*** (koyedeji@morehouse.edu), Morehouse College, Atlanta, GA 30314, and **Ronald E. Mickens** (rohrs@math.gatech.edu), Clark Atlanta University, Atlanta, GA 30314. *Mathematical Restrictions on Purely Dissipative Forces.*

Friction or dissipative forces place important roles in the understanding of diverse phenomena in the natural and engineering sciences. However, in the construction of mathematical models for such systems such forces are generally taken to be linear functions of the velocity, i.e., proportional to the first time-derivative of a coordinate. For elementary systems, such a representation gives rise to dynamics which go to an equilibrium state after an arbitrarily long time, i.e., "infinite" time. But, in fact, actual systems as they occur in nature, reach equilibrium after a finite interval of time. Based on an extension of previous work by Mickens [1], it is shows that friction/dissipative force laws exist such that the dynamics is of finite duration. This important result follows from first formulating a clear, physical based derivation of the general properties of purely dissipative forces, and then analyzing in detail the possible solution behaviors of an elementary physical system acted on by a power-law type force. An interesting result is that dissipative forces exist for which the system does not "stop" in a finite time.

[1] R. E. Mickens, Nonlinear Oscillations (Cambridge University Press, 1981). (Received July 29, 2011)

1073-34-160 **Judy Day*** (judyday@gmail.com), University of Tennessee - Dept of Mathematics, 227 Ayres Hall, 1403 Circle Drive, Knoxville, TN 37996-1320, and **Avner Friedman** and **Larry S Schlesinger**. *Modeling the Host Response to Respiratory Pathogens: Mycobacterium Tuberculosis and Bacillus Anthracis.*

To better understand the pathogenesis of respiratory pathogens such as *Mycobacterium Tuberculosis* or *Bacillus Anthracis*, we developed mathematical models of host interaction with these pathogens, using literature focused specifically on native lung cell types to guide our selection of interactions that we modeled. In so doing, we offer a different perspective from previous modeling efforts and offer insights into possible points of intervention and control of the particular infection. (Received July 31, 2011)

1073-34-215 **Zachary J. Abernathy*** (abernathyz@winthrop.edu) and **Jesus Rodriguez**. *On the Solvability of Sturm-Liouville Problems with Non-Local Boundary Conditions.*

In this talk, we establish sufficient conditions for the existence of solutions to the nonlinear differential equation

$$(p(t)x'(t))' + q(t)x(t) + \psi(x(t)) = G(x(t))$$

subject to general non-local boundary conditions of the form

$$\begin{cases} \alpha x(0) + \beta x'(0) + \eta_1(x) = \phi_1(x) \\ \\ \gamma x(1) + \delta x'(1) + \eta_2(x) = \phi_2(x). \end{cases}$$

The results obtained in this talk depend in a crucial way on the relationship between the eigenvalues of a linear Sturm-Liouville problem and the rate of growth of nonlinearities present in both the differential equation and the boundary conditions. (Received August 01, 2011)

35 ► Partial differential equations

1073-35-6 **Sarath Sasi*** (ss885@msstate.edu). *Alternate Stable States in Ecosystems.*

We consider the existence of multiple positive solutions to the steady state reaction diffusion equation with Dirichlet boundary conditions of the form:

$$\begin{cases} -\Delta u = \lambda[u - \dfrac{u^2}{K} - c\dfrac{u^2}{1+u^2}], \quad x \in \Omega, \\ \quad u = 0, \quad x \in \partial\Omega. \end{cases}$$

Here $\Delta u = div(\nabla u)$ is the Laplacian of u, $\frac{1}{\lambda}$ is the diffusion coefficient, K and c are positive constants and $\Omega \subset \mathbb{R}^N$ is a smooth bounded region with $\partial\Omega$ in C^2. This model describes the steady states of a logistic growth model with grazing in a spatially homogeneous ecosystem. It also describes the dynamics of the fish population with natural predation. In this paper we discuss the existence of multiple positive solutions leading to the occurrence of an S-shaped bifurcation curve. We also introduce a constant yield harvesting term to this model and discuss the existence of positive solutions including the occurrence of a Σ-shaped bifurcation curve in the case of a one-dimensional model. We prove our results by the method of sub-super solutions and quadrature method. (Received July 19, 2011)

1073-35-7 **Lakshmi Sankar Kalappattil*** (lk154@msstate.edu), **Eun Kyoung Lee** and **R. Shivaji**. *Positive solutions for infinite semipositone problems on exterior domains.*

We study positive radial solutions to the problem

$$\begin{cases} -\Delta u = \lambda K(|x|)f(u), & x \in \Omega \\ \quad u = 0, & \text{if } |x| = r_0 \\ \quad u \to 0 & \text{as } |x| \to \infty, \end{cases} \tag{1}$$

where λ is a positive parameter, $\Delta u = \text{div}(\nabla u)$ is the Laplacian of u, $\Omega = \{x \in \mathbb{R}^n, n > 2 | |x| > r_0\}$ is an exterior domain and $f : (0, \infty) \to \mathbb{R}$ belongs to a class of sublinear functions at ∞ such that they are continuous and $f(0^+) = \lim_{s\to 0^+} f(s) < 0$. In particular we also study infinite semipositone problems where $\lim_{s\to 0^+} f(s) = -\infty$. Here $K : [r_0, \infty) \to (0, \infty)$ belongs to a class of continuous functions such that $\lim_{r\to\infty} K(r) = 0$. We establish various existence results for such boundary value problems and also extend our results to classes of systems. We prove our results by the method of sub-super solutions. (Received July 30, 2011)

1073-35-45 **Guangming Yao*** (guangmingyao@gmail.com), 3200 N. Cramer St., Milwaukee, WI.
Localized Method of Approximate Particular Solutions for Solving Reaction-Diffusion Equations. Preliminary report.

In this paper, we extend the localized method of approximate particular solutions(LMAPS) to solving reaction-diffusion equations with different boundary conditions and node distributions. The following 3D PDE is considered:

$$\frac{\partial u}{\partial t} = D\nabla^2 u + f(u), \tag{1}$$

where D, t, u stand for diffusion coefficient, time and concentration, respectively. f is a function of unknown variable u in which $u = u(x, y, z, t), (x, y, z) \in \Omega \bigcup \partial\Omega$. We seek the solution of the above equation provided that the initial value of u and boundary conditions are known. The LMAPS allows the use of a small neighborhood of points to find the approximate solution of the given partial differential equation. The time space can be discretized in an implicit way, which leads more stable result compared with explicit methods. (Received July 20, 2011)

1073-35-47 **R. Shivaji*** (r_shivaj@uncg.edu), **D. D. Hai** and **Lakshmi Sankar**. *An existence result for an infinite semipositone problem with asymptotically linear growth at ∞.*

We study the existence of positive solutions to the singular problem

$$\begin{cases} -\Delta u = \lambda f(u) - \dfrac{1}{u^\alpha} & \text{in } \Omega, \\ u = 0 & \text{on } \partial\Omega, \end{cases}$$

where λ is a positive parameter, Ω is a bounded domain in $\mathbb{R}^n, n \geq 1$ with smooth boundary $\partial\Omega$, $0 < \alpha < 1$ and $f : [0, \infty) \to \mathbb{R}$ is a continuous function which is asymptotically linear at ∞. We discuss the existence of positive solutions for a certain range of λ. We also discuss extensions to the case of $p-$Laplacian operators and systems. (Received July 21, 2011)

1073-35-48 **Eunkyung Ko*** (ek94@msstate.edu), 319 N.Jackson st. 1A, Starkville, MS 39759.
Uniqueness and multiplicity results for classes of infinite positone problems.

We study positive solutions to the singular boundary value problem

$$\begin{aligned} -\Delta u &= \lambda \frac{f(u)}{u^\beta} \qquad \text{in } \Omega, \\ u &= 0 \text{ on } \partial\Omega, \end{aligned}$$

where λ is a positive parameter, $\beta \in (0, 1)$ and Ω is a bounded domain in $\mathbb{R}^N, N \geq 1$. Here $f \in C([0, \infty), (0, \infty))$ is nondecreasing and satisfies $\lim_{u\to\infty} \frac{f(u)}{u^{\beta+1}} = 0$. We discuss the existence of multiple positive solutions for a certain range of λ and a uniqueness result for $\lambda \gg 1$. A simple model that will satisfy our hypotheses is $f(u) = e^{\frac{\alpha u}{\alpha+u}}$ for $\alpha \gg 1$. We extend our multiplicity result to classes of systems, including $p-$Laplacian systems, when the nonlinearities satisfy certain combined sublinear conditions at infinity. We also extend our results to the case when Ω is an exterior domain. (Received July 21, 2011)

1073-35-58 **John M Neuberger*** (john.neuberger@nau.edu), Department of Mathematics and Statistics, Box 5717, Northern Arizona University, Flagstaff, AZ 86011, and **Jeffrey Springer**. *Numerical Solutions of Semilinear Elliptic PDE on Manifolds.* Preliminary report.

We extend the Gradient Newton Galerkin Algorithm (GNGA) to semilinear elliptic PDE on manifolds. In particular, we apply our methods by first finding an orthonormal basis of eigenfunctions of the Laplace-Beltrami operator for any given manifold. In this preliminary report, we consider several simple manifolds where the eigenfunctions are known in closed form, and then discuss the Closest Point (CP) method as a means to find a suitable basis for other manifolds. After obtaining these eigenfunctions, we construct bifurcation diagrams corresponding to a family of superlinear PDE. (Received July 25, 2011)

1073-35-63 **Matthew D Blair*** (blair@math.unm.edu), Department of Mathematics and Statistics, MSC01 1115, 1 University of New Mexico, Albuquerque, NM 87110. *Strichartz estimates in polygonal domains.*

Strichartz inequalities are a family of space-time integrability estimates for the wave equation that rely on the dispersive effect of the solution map. They are of interest due to their applications to nonlinear equations. These estimates are reasonably well-understood when the equation is posed over Euclidean space. However, the situation is more intricate when one starts to consider problems posed on polygonal domains. This is due to the fact that boundary conditions affect the flow of energy. Nonetheless, we will see that such inequalities are valid in this context. This is a joint work with G.A. Ford and J. Marzuola. (Received July 25, 2011)

1073-35-74 **Matthew B. Rudd*** (mbrudd@sewanee.edu). *Statistical approximations of p-harmonic functions.*

I will discuss recent work on variants of the mean value property related to p-harmonic functions of two variables. When $p = 1$ and data are prescribed on the boundary of a domain Ω, we have a local median value property that is either easy or impossible to solve, depending on how the data and the geometry of $\partial\Omega$ interact. When $p > 1$, we have statistical functional equations that provide elementary algorithms for computing p-harmonic functions with given boundary values. (Received July 26, 2011)

1073-35-78 **Junping Shi*** (shij@math.wm.edu), Department of Mathematics, College of William and Mary, Williamsburg, VA 23187. *Existence and Uniqueness of Positive Solution for Sublinear Elliptic Systems.*

It is well-known that appropriately defined scalar sublinear elliptic equation has a unique positive solution. We extend the definition of sublinearity to systems of semilinear elliptic systems, and we prove the existence and uniqueness of positive solutions under several different assumptions. This is a joint work with Renhao Cui, Ping Li, Yuwen Wang and Boying Wu. (Received July 27, 2011)

1073-35-80 **John A Helms*** (johelms@email.unc.edu), John Helms, University of North Carolina at Chapel Hill, CB #3250, Phillips Hall, Chapel Hill, NC 27599, and **Jason L Metcalfe**. *Lifespan of Quasilinear Wave Equations in Exterior Domains.* Preliminary report.

In joint work with Jason Metcalfe, we investigated the lifespan of wave equations of the form $(\partial_t^2 - \Delta)u = Q(u, u', u'')$ in $[0, T] \times \mathbb{R}^3 \backslash \mathcal{K}$, where $\mathcal{K}$ is an exterior domain. Previous results have demonstrated longtime existence in the case that $\mathcal{K}$ was assumed to be star-shaped. In this talk, we will see that the same lifespan holds for more general geometries, where we only assume a local decay of energy with a possible loss of regularity for specific solutions to the linear wave equation. (Received July 27, 2011)

1073-35-100 **Mihai H Tohaneanu*** (mihaitohy@gmail.com), 3811 Canterbury Rd Apt 306, Baltimore, MD 21218. *Pointwise decay on nonstationary spacetimes.*

Let u be a solution to the equation $\Box_g u = 0$ where g is some (nonstationary) Lorentzian metric and $\Box_g$ its associated d'Alembertian. If we assume a priori that certain local energy norms for u and its higher derivatives hold, we can prove that u decays pointwise like t^{-3} in a compact region. As an application, we can prove the aforementioned decay on Kerr spacetimes and some perturbations. This is joint work with Jason Metcalfe and Daniel Tataru. (Received July 28, 2011)

1073-35-124 **Ronald E. Mickens*** (rohrs@math.gatech.edu), Clark Atlanta University, Atlanta, GA 30314. *Influence of Birth/Death Rate Functional Forms on Predator-Prey Dynamics.*

Many of the standard models in predator-prey population dynamics assume a (positive) linear term for the prey (x) net birth rate, and a corresponding (negative) net death rate of the predator (y). By themselves, these terms give, respectively, exponentially growth and death of the prey and predator populations. We investigate the mathematical consequences of using two other functional forms for the net prey birth/death rate, i.e., $(k - \mu x)$ and $Bx(1 - Dx)$, where (k, μ, B, D) are constant parameters. In particular, the following issues are considered: (i) For each model, how many fixed-points (FP) or equilibrium states exist? (ii) For each FP, what is its linear stability properties? (iii) What is the general nature of the trajectories in the $(x - y)$ phase-plane? (iv) Are there features of the dynamics that are independent of the functional form selected for the net birth/death of the prey population? The relevance of these results within the restriction of dynamic consistency will be discussed. (Received July 29, 2011)

1073-35-126 **Evans M Harrell*** (harrell@math.gatech.edu), School of Mathematics, Georgia Institute of Technology, Atlanta, GA 30332-0160. *Hardy inequalities and the spectra of Laplace and p-Laplace operators.*

I will discuss a result of Boggio that implies Hardy-type inequalities, and will use the latter to derive some bounds on spectral gaps and estimates on eigenfunctions for PDEs containing p-Laplacians. Some of this work was joint with Fleckinger and de Thelin. (Received July 29, 2011)

1073-35-129 **Marius Beceanu*** (mbeceanu@math.rutgers.edu), 110 Frelinghuysen Rd., Rutgers University Math. Dept., Piscataway, NJ 08854. *Structure of wave operators in R^d.*

We prove a structure formula for the wave operators in $\mathbb{R}^3$

$$W_{\pm} = \lim_{t \to \pm\infty} e^{it(-\Delta + V)} P_c e^{it\Delta}$$

and their adjoints for a scaling-invariant class of scalar potentials $V \in B$,

$$B = \Big\{ V | \sum_{k\in\mathbb{Z}} 2^{k/2} \|\chi_{|x|\in[2^k,2^{k+1}]}(x)V(x)\|_{L^2} < \infty \Big\},$$

under the assumption that zero is neither an eigenvalue, nor a resonance for $-\Delta + V$.
The formula implies the boundedness of wave operators on L^p spaces, $1 \le p \le \infty$, on weighted L^p spaces, and on Sobolev spaces, as well as multilinear estimates for $e^{itH}P_c$.
When V decreases rapidly at infinity, we obtain an asymptotic expansion of the wave operators. The first term of the expansion is of order $\langle y\rangle^{-4}$, commutes with the Laplacian, and exists when $V \in \langle x\rangle^{-3/2-\epsilon}L^2$.
We also prove that the scattering operator $S = W_-^* W_+$ is an integrable combination of isometries.
The proof is based on an abstract version of Wiener's theorem, applied in a new function space. (Received July 30, 2011)

1073-35-133 **Hossein Tehrani*** (tehranih@unlv.nevada.edu) and **David Costa**. *On Homoclinic Solutions for a Class of Singular Hamiltonian Systems.*

We consider a second order singular Hamilyonian system:

$$u'' + \nabla_u W(t,u) = 0$$

where $W(t,u) = a(t)V(u)$, the function $a : \mathbb{R} \to \mathbb{R}$ is a positive continuous $T-$ periodic function and the nonpositive potential $V : \mathbb{R}^N/q \to \mathbb{R}$ has a strict globall maximum at zero: $V(u) < V(0) = 0$ for $u \neq 0$, and $\lim_{x\to q} V(x) = -\infty$. Existence of homoclinic orbits to zero is studied. (Received July 30, 2011)

1073-35-162 **M. N. Nkashama*** (nkashama@math.uab.edu), Department of Mathematics, University of Alabama at Birmingham, Birmingham, AL 35294-1170, and **N. Mavinga** (mavinga@swarthmore.edu), Department of Mathematics & Statistics, Swarthmore College, Swarthmore, PA 19081-1390. *Nonresonance on the boundary and strong solutions of elliptic equations with nonlinear boundary conditions.*

We deal with the solvability of linear second order elliptic partial differential equations with nonlinear boundary conditions by imposing asymptotic nonresonance conditions of nonuniform type with respect to the Steklov spectrum on the boundary nonlinearity. Unlike some recent approaches in the literature for problems with nonlinear boundary conditions, we cast the problem in terms of nonlinear compact perturbations of the identity on appropriate *trace spaces* in order to prove the existence of strong solutions. The proofs are based on *a priori* estimates for possible solutions to a homotopy on suitable trace spaces and topological degree arguments. (Received July 31, 2011)

1073-35-163 **Jan Chabrowski** and **David G. Costa*** (costa@unlv.nevada.edu), Department of Mathematical Sciences, University of Nevada Las Vegas, Las Vegas, NV 89154-4020. *Positive solutions for a class of Caffarelli-Kohn-Nirenberg type equations in $\mathbb{R}^N$.*

We study existence of positive solutions for a singular equation of Caffarelli-Kohn-Nirenberg type in $\mathbb{R}^N$ having a critical-like nonlinearity with a sign-changing weight function. This is done by investigating how the properties of the Nehari manifold and the fibering mappings affect the existence of positive solutions. (Received July 31, 2011)

1073-35-170 **N. Mavinga*** (mavinga@swarthmore.edu), Department of Mathematics and Statistics, Swarthmore College, Swarthmore, PA 19081-1390, and **M. N. Nkashama**, Department of Mathematics, University of Alabama at Birmingham, Birmingham, AL 35294-1170. *Generalized Eigenproblem and Nonlinear Elliptic Equations at Resonance.*

We consider a generalized Steklov-Robin eigenproblem (with possibly singular weights) in which the spectral parameter is both in the differential equation and on the boundary and prove existence results for nonlinear elliptic equations when both nonlinearities in the differential equation and on the boundary interact, in some sense, with the generalized spectrum. The proofs are based on variational methods, a priori estimates and topological degree techniques. (Received August 01, 2011)

1073-35-188 **M Burak Erdogan***, Department of Mathematics, University of Illinois, Urbana, IL 61801, and **Nikos Tzirakis**, Department of Mathematics, University of Illinois, Urbana, IL 61801. *Smoothing for the KdV equation with periodic boundary conditions.*

We consider the Korteweg-de Vries (KdV) equation with periodic boundary conditions. We prove that for H^s initial data, $s > -1/2$, and for any $s_1 < \min(3s+1, s+1)$, the difference of the nonlinear and linear evolutions is in H^{s_1} for all times, with at most polynomially growing H^{s_1} norm. The result also extends to KdV with a smooth, mean zero, time-dependent potential in the case $s \ge 0$.

A corollary of this result and a theorem of Oskolkov state that if one starts with continuous and bounded variation initial data then the solution of KdV is a continuous function of space and time.

Another corollary is the smoothing for the modified KdV equation on the torus for $s > 1/2$. (Received August 01, 2011)

1073-35-194 **Brian Pigott***, bpigott@math.toronto.edu. *Polynomial-in-time upper bounds for the orbital instability of the subcritical generalized Korteweg-deVries equations.*

We will discuss some of the details relevant in establishing polynomial-in-time upper bounds on the orbital instability of the generalized KdV equations below H^1. The talk will focus on the construction of an almost conserved quantity which can be used to establish these upper bounds. (Received August 01, 2011)

1073-35-195 **J. Douglas Wright*** (jdoug@math.drexel.edu), **David Ambrose**, **Gideon Simpson** and **Dennis Guang Yang**. *Well-posedness issues for 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 August 01, 2011)

1073-35-206 **Justin Holmer*** (holmer@math.brown.edu), Department of Mathematics, Box 1917, 151 Thayer St, Providence, RI 02912, and **Quanhui Lin**. *Phase-driven interaction of widely separated nonlinear Schrödinger solitons.*

We show that, for the 1d cubic NLS equation, widely separated equal amplitude in-phase solitons attract and opposite-phase solitons repel. Our result gives an exact description of the evolution of the two solitons valid until the solitons have moved a distance comparable to the logarithm of the initial separation. Our method does not use the inverse scattering theory and should be applicable to nonintegrable equations with local nonlinearities that support solitons with exponentially decaying tails. The result is presented as a special case of a general framework which also addresses, for example, the dynamics of single solitons subject to external forces. (Received August 01, 2011)

1073-35-230 **Nicoleta Virginia Bila*** (nbila@uncfsu.edu), Fayetteville State University, Dept of Mathematics and Computer Science, 1200 Murchison Road, Fayetteville, NC 28301. *GENDEFGET - a MAPLE subroutine based on a new method for finding equivalence transformations.*

A new efficient method for finding the generalized equivalence transformations related to a differential equation system via its extended classical symmetries is presented. This technique applies to the case when the arbitrary functions involve only the independent variables of the system. Intriguingly, for this type of equations, any symbolic manipulation program designed to find classical Lie symmetries can also be used to determine generalized equivalence transformations, without any modification of the program. The method has been implemented as the MAPLE routine GENDEFGET and is based on the MAPLE package DESOLV (authors Carminati and Vu). The nonlinear stationary heat conduction equation is considered as an example. (Received August 02, 2011)

1073-35-266 **Alfonso Castro*** (alfonso_castro@hmc.edu), Department of Mathematics, Harvey Mudd College, Claremont, CA 91711. *A semilinear wave equation with non-monotone nonlinearity*

Recent results on existence and regularity of solutions to semilinear wave equations are discussed. The key issue is that the derivative of the nonlinearity includes and eigenvalue of infinite multiplicity. The role of approximate solutions not vanishing on sets of positive measure of characteristics is emphasized. (Received August 05, 2011)

1073-35-267 **Magdalena Czubak*** (czubak@math.toronto.edu), University of Toronto. *Magnetic interaction Morawetz estimates and applications.*

We establish an interaction Morawetz estimate for the magnetic Schr odinger equation under certain smallness conditions on the gauge potentials. We discuss applications to wellposedness and scattering. This is joint work with J. Colliander and J. Lee. (Received August 09, 2011)

1073-35-268 **David M. Ambrose*** (ambrose@math.drexel.edu), Drexel University, and **J. Douglas Wright** (jdoug@math.drexel.edu), Drexel University. *Existence Theory for Some Equations with Degenerate Dispersion*

We consider the initial value problem for some equations with degenerate dispersion. On well-known equation with degenerate dispersion is the $K(2,2)$ equation of Rosenau and Hyman, $u_t = (u^2)_{xxx} + (u^2)_x$. Existence theory for this and similar equations is difficult, owing to a lack of useful conserved quantities and a priori estimates. We show that for a certain family of equations with degenerate dispersion, short-time existence theory in Sobolev spaces is possible, and for certain members of this family, there are global solutions. Furthermore, for the equations which exhibit global solutions, there are also compactly supported traveling waves in the same function space. (Received August 09, 2011)

37 ► Dynamical systems and ergodic theory

1073-37-33 **Miaohua Jiang*** (jiangm@wfu.edu), PO BOX 7388, Wake Forest University, Department of Mathematics, Winston Salem, NC 27109. *A deterministic contact network model of epidemics.* Preliminary report.

We introduce a simple SIS epidemic model over an arbitrary static contact network. The basic reproductive number of the model is represented by the logarithm of the topological pressure of a potential function in terms of transmission and recovery probabilities. This simple model allows us to study the dependence of the basic reproduction number on the topology of the network, the transmission probabilities between any two individuals, as well as the recovery probability of any individual in the network. (Received July 14, 2011)

1073-37-213 **Abhishek Pandey*** (abhishe@g.clemson.edu), Mathematical Sciences, Clemson University, M-304 Martin Hall, Clemson, SC 29634-0975. *Parameter Estimation and Model Selection for Dengue Transmission.* Preliminary report.

The study of dengue dynamics at the population scale have significantly contributed to the understanding of dengue transmission. Most studies have used point estimates of parameter values derived from clinical and laboratory experiments: in particular, data on population-level parameters such as transmission or susceptibility are extremely limited due to inability to feasibly conduct experiments of infection in people and instead must be estimated from indirect population-level data. We suggest a Bayesian approach which uses Monte Carlo Markov Chain (MCMC) simulation to find estimates for the unknown parameters of a generic dengue mathematical model we formulated based on previous dengue models. Prior knowledge is combined with data on hospital visits to perform the statistical inference on the unknown parameters. Our model allows for the inclusion of different hypotheses about dengue epidemiology and we explore the consistency of clinical data with the epidemiological hypothesis by determining goodness of fit of the model to the data for each combination of hypothesis. We use Akaike Information Criterion and Bayes Information Criterion on the results from the Bayesian MCMC on our dengue model and select a model that most parsimoniously agrees with the data. (Received August 01, 2011)

39 ► Difference and functional equations

1073-39-149 **Kristen K. Abernathy*** (kristenkobylus@hotmail.com) and **Jesus Rodriguez**. *Nonlocal boundary value problems for discrete systems.*

In this talk, we study nonlinear discrete systems of the form

$$y(k+n) + \cdots + a_0(k)y(k) = f(y(k)) + \sum_{l=0}^{J} w(k,l)g(l, y(l), \cdots, y(l+n-1))$$

subject to the multipoint boundary conditions

$$\sum_{j=1}^{n} b_{ij}(0)y(j-1) + \sum_{j=1}^{n} b_{ij}(1)y(j) + \cdots + \sum_{j=1}^{n} b_{ij}(J)y(j+J-1) = 0$$

for $i = 1, 2, \cdots, n$. The criteria we present depends on the size of the nonlinearity and the set of solutions to the corresponding linear, homogeneous boundary value problem. Our analysis is based on the Lyapunov-Schmidt Procedure and Brouwer's Fixed Point Theorem. The results presented extend the previous work of D. Etheridge and J. Rodriguez, and J. Rodriguez and P. Taylor. (Received July 31, 2011)

40 ► Sequences, series, summability

1073-40-169 **Amanda J Bienz*** (abienz@elon.edu), 3531 Campus Box, Elon University, Elon, NC 27244. *Magic Polygrams.*

Polygrams, such as hexagrams and octograms, are considered magic when every row shares a common sum, or magic constant. A computer can find magic polygrams through exhaustive searches. However, for most polygrams, there are too many possible arrangements for a computer to handle, so these must be limited algorithmically. Acquiring the possible arrangements of even and odd numbers as well as the range in which the magic constant must fall can reduce the number of permutations enough that a computer can find the solutions. (Received August 01, 2011)

41 ► Approximations and expansions

1073-41-102 **Boaz Ilan*** (bilan@ucmerced.edu), 5200 N. Lake Rd., Merced, CA 95343, and **Mark A Hoefer** (hoefer.mark@gmail.com), Department of Mathematics, Box 8205, NC State University, Raleigh, NC 27695-8205. *Transverse instabilities of dark solitons and dispersive shocks.*

Transverse instabilities of dark solitons and dispersive shock waves for the (2+1)-dimensional defocusing nonlinear Schrödinger / Gross-Pitaevskii equation is considered. Asymptotics and computation 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 other physical systems. (Received July 28, 2011)

1073-41-165 **Evans Harrell** (harrell@math.gatech.edu), Atlanta, GA 30332, and **Manwah Lilian Wong*** (wong@math.gatech.edu), 686 Cherry Street, School of Mathematics, Georgia Tech, Atlanta, GA 30332. *Dichotomy and behavior at infinity of solutions to difference equations.*

We study pairs of discrete Schrödinger equations whose potential functions differ by a small quantity. With simple assumptions on the growth rate of the solutions of the original system, we show that the perturbed system has a fundamental set of solutions with the same exponential behavior at infinity, and employ a variation-of-constants scheme to produce a convergent iteration for the solutions of the second equation in terms of those of the original one. We use the relations between the solution sets of the two equations to investigate exponential dichotomy of solutions and the structure of transfer matrices.

Later, we present a sharp discrete analogue of the Liouville-Green (WKB) transformation, making it possible to derive exponential behavior at infinity of a single difference equation, by explicitly constructing a comparison equation differing from it by a small perturbation.

We present several perspectives on the behavior of solutions at infinity. First we offer a geometric approach, to be followed by an asymptotic analytic approach of the recurrence matrices. (Received July 31, 2011)

42 ► Fourier analysis

1073-42-87 **Vita Borovyk** and **Michael Goldberg***, University of Cincinnati, Department of Mathematical Sciences, Old Chem Hall, Cincinnati, OH 45221-0025. *Wave Propagation on Square Lattices.* Preliminary report.

We study dispersive estimates for the wave equation on a square lattice with non-isotropic coupling between nodes. The fundamental solution is found by evaluating oscillatory integrals which may possess stationary phase points of various degenerate types. The degree and type of degeneracy in turn determines the power-law for dispersion at the selected points. For the two-dimensional lattice, the resulting propagator has maximum amplitude $|t|^{-3/4}$, moving along rays with a velocity $\mathbf{v}_0$ that is unique up to mirror symmetry. (Received July 27, 2011)

51 ► Geometry

1073-51-9 **Rafal Komendarczyk*** (rafkom@gmail.com), 6823 St. Charles Ave, New Orleans, LA 70118. *Higher order helicities via link maps.*

I will present a perspective on asymptotic higher linking numbers, which exploits homotopy invariants of maps associated to n-component links into configuration spaces. As a particular application, I will show how this approach leads to a lower bound for the L^2-energy of a volume preserving vector field on domains with the third order linkage present but no 2nd order linkage. This result can be considered as an extension of the classical energy bound by V.I. Arnold which is relevant for domains with the 2nd order linkage. (Received May 30, 2011)

1073-51-72 **Sean V. Droms*** (svd5d@virginia.edu). *Constructions of Stein Fillings.*

We reprove a result due to Akhmedov, Etnyre, Mark and Smith: using Heegaard-Floer homology, we show the existence of infinitely many simply-connected, homeomorphic but not diffeomorphic Stein fillings of a particular contact 3-manifold (M, ξ). We will discuss possible extensions to this result with an eye towards decreasing the Betti numbers of M or the page genus of the induced compatible open book decomposition. (Received July 26, 2011)

52 ► Convex and discrete geometry

1073-52-77 **Tamás Kálmán*** (kalman@math.titech.ac.jp). *Tutte's polynomial for hypergraphs and polymatroids.*

Given an integer-valued submodular set function μ, I will define two polynomial invariants of the corresponding polymatroid that generalize the valuations $T(x, 1)$ and $T(1, y)$ of the Tutte polynomial of matroids. The definitions use extensions of Tutte's notions of internal and external activity to the integer lattice points in the base polytope B_μ. I will state several properties of the new polynomials (including deletion-contraction formulas and a conjectural relation to the h-vector of root polytope triangulations) for a class of polymatroids derived from hypergraphs. If we further specialize to hypergraphs that can be drawn as plane bipartite graphs, we obtain a version of the planar duality rule for T, as well as a connection to Tutte's Tree Trinity Theorem. Some of these results are joint with Alex Postnikov. (Received July 27, 2011)

53 ► Differential geometry

1073-53-175 **Bulent Tosun*** (btosun3@math.gatech.edu), 686 Cherry St School of Math, Georgia Institute of Technology, Atlanta, GA 30332. *Legendrian and transverse knots in cabled knot types.*

In this talk we will exhibit many new phenomena in the structure of Legendrian and transverse knots by giving a complete classification of all cables of the positive torus knots. We will also provide two structural theorems to ensure when cable of a Legendrian simple knot type is also Legendrian simple. Part of the results are joint work with John Etnyre and Douglas LaFountain (Received August 01, 2011)

1073-53-222 **Jason Cantarella*** (jason.cantarella@gmail.com), UGA Math Department, Boyd GSRC, Athens, GA 30602. *Grassmannians, polygons and curves in $\mathbb{R}^2$ and $\mathbb{R}^3$.* Preliminary report.

This (mostly expository) talk explains the identification between the Grassmannian $\mathbb{C}(2, n)$ and the space of n-gons in $\mathbb{R}^3$ given by Knutson and Haussman and extends it to space curves. This gives a new way to look at curves in two and three dimensions which seems likely to be quite useful in explaining geometric properties of knots and polygons. (Received August 01, 2011)

1073-53-253 **Jason Parsley*** (parslerj@wfu.edu). *The geometry of the Taylor problem in plasma physics.*

Plasma injected into a toroidal container loses energy rapidly until it reaches a quasi-stable state while its helicity (an average linking number of its field lines) remains essentially constant. J.B. Taylor showed that by also fixing the flux of the field – assumed divergence free and tangent to the boundary – through a cross-sectional disk, the resulting minimal energy field well approximates experimental results. We consider the problem of Taylor on arbitrary subdomains in R^3. We show a solution always exists and investigate the role of geometry on the problem. (Received August 02, 2011)

54 ► General topology

1073-54-31 **Alan Dow** (adow@uncc.edu), Department of Mathematics and Statistics, University of North Carolina at Charlotte, Charlotte, NC 28223, and **Jerry E Vaughan*** (j_vaugha@uncg.edu), Department of Mathematics and Statistics, University of North Carolina at Greensboro, Greensboro, NC 27412. *Ordinal remainders of ψ-spaces on ω.*

Let ω denote the set of natural numbers, and $\mathfrak{t}$ the tower number. We prove: For every ordinal $\lambda < \mathfrak{t}^+$, there exists $\mathcal{M} \subset [\omega]^\omega$, an infinite maximal almost disjoint family of infinite subsets of the natural numbers (MADF), such that the Stone-Čech remainder, $\beta\psi \setminus \psi$, of the ψ-space, $\psi = \psi(\omega, \mathcal{M})$, is homeomorphic to $\lambda + 1$ with the order topology. This generalizes a result credited to S. Mrówka by J. Terasawa which states that there is MADF $\mathcal{M}$ such that $\beta\psi \setminus \psi$ is homeomorphic to $\omega_1 + 1$. We construct our MADF from an ascending mod-finite ordered chain of infinite subsets of ω, ordered by almost inclusion. (Received July 11, 2011)

1073-54-41 **Harold Bennett**, **Dennis Burke** and **David Lutzer*** (lutzer@math.wm.edu). *Some Questions on Rotoids.* Preliminary report.

A space X is a rotoid if there is a special point $e \in X$ and a homeomorphism F from X^2 onto itself with the properties: (i) $F(x, x) = (x, e)$ for all $x \in X$, and (ii) $F(e, x) = (e, x)$ for all $x \in X$. If an arbitrary point of X can be used as the special point e, then X is a strong rotoid(Arhangelskii). Every topological group $(G, *)$ is a rotoid and previous research has shown that certain theorems for topological groups can be proved for some more general spaces. For example, A. Gulko proved that first-countable T_3 rectifiable spaces, and T_3 rectifiable spaces with countable π-character, are metrizable, where rectifiable spaces are another type of space with a flexible diagonal. Any rectifiable space is a rotoid, and Arhangelskii asked four questions about rotoids:

8.13 Is every strong rotoid rectifiable?

8.20 Is the Sorgenfrey line a rotoid?

8.21 Is every first-countable (strong) rotoid metrizable?

8.22 Is every (strong) rotoid of countable π-character metrizable?

In this paper answer 8.20 affirmatively, thereby answering the other three questions negatively, and we show that other familiar spaces, such as the Michael line, are not rotoids. (Received July 19, 2011)

1073-54-54 **Thomas W Kephart*** (tom.kephart@gmail.com), Physics Department, Vanderbilt University, Nashville, TN 37235, and **Philipp Leser** and **Heinrich Päs**. *Knotted strings and leptonic flavor structure.*

Tight knots and links arising in the infrared limit of string theories may provide an interesting alternative to flavor symmetries for explaining the observed flavor patterns in the leptonic sector. As an example we consider a type I seesaw model where the Majorana mass structure is based on the discrete length spectrum of tight knots and links. It is shown that such a model is able to provide an excellent fit to current neutrino data and that it predicts a normal neutrino mass hierarchy as well as a small mixing angle θ_{13}. (Received July 23, 2011)

1073-54-62 **Harold Bennett** and **Dennis Burke***, Department of Mathematics, Miami University, Oxford, OH 45056, and **David Lutzer**. *Choban operators in GO spaces.*

A space X is a *Choban space* if there is a continuous $h : X \times X \to X$ satisfying: (a) there is $e \in X$ with $h(x, x) = e$ for all $x \in X$, and (b) for each $x \in X$, h maps $\{x\} \times X$ onto X in a one-to-one way. Such h would be called a *Choban operator*. As observed by Arhangel'skii, every topological group $(G, *)$ is a Choban space by using the operator h defined as $h(a, b) = a * b^{-1}$. One quickly sees that $\mathbb{R}$, $\mathbb{R} \setminus \{0\}$, $\mathbb{Q}$, $\mathbb{P}$ (irrationals), the Cantor set and the open interval $(0, 1)$ are Choban spaces. The closed interval $[0, 1]$ is not a Choban space.

Within the class of GO spaces the existence of a Choban operator on a space imposes some conditions on the topology of the space. A GO space X with a Choban operator is hereditarily paracompact. A first countable LOTS with a Choban operator is metrizable. This uses a result in general spaces which says that if a space X has a Choban operator and has countable pseudo-character at the special point e then X has a G_δ-diagonal.

Other interesting examples include the Sorgenfrey line $\mathbb{S}$ and the Michael line $\mathbb{M}$. Both are Choban spaces. (Received July 25, 2011)

1073-54-66 **Alexander Shibakov***, Math Dept, Box 5054, Cookeville, TN 38605-0001. *A note on the bagpipe lemma.* Preliminary report.

We present a possible approach to proving Nyikos' bagpipe lemma in dimensions higher than 2. We then apply the approach to a class of nonmetrizable manifolds that satisfy a stronger version of simple connectedness. (Received July 25, 2011)

1073-54-128 **L P Aiken*** (laiken1@gmu.edu), Department of Mathematical Sciences, George Mason University, 4400 University Drive, Fairfax, VA 22030. *Star-covering properties: generalized Ψ-spaces, countability conditions, reflection.*

For a topological property $\mathcal{P}$, we say that a space X is star-$\mathcal{P}$ if and only if for every open cover $\mathcal{U}$ of X there exists a subspace Y of X such that $\mathrm{st}(Y,\mathcal{U}) = X$ and Y has property $\mathcal{P}$. We investigate several star-covering properties of Ψ-like spaces. In addition, we show that star-Lindelöfness is reflected by open perfect mappings and offer a new topological equivalence of the Continuum Hypothesis. (Received July 30, 2011)

1073-54-131 **Keith M Fox*** (kmcauliffefox@gmail.com). *A Characterization of The Witnesses to The Non-Normality of $\mathbb{N}^{\omega_1}$.* Preliminary report.

We expand on A.H. Stone's 1948 result that $\mathbb{N}^{\omega_1}$ is not normal, by characterizing the closed sets which witness the non-normality of $\mathbb{N}^{\omega_1}$. We give necessary and sufficient conditions on closed sets $Z \subset \mathbb{N}^{\omega_1}$ for the existence and construction of a closed set $Z' \subset \mathbb{N}^{\omega_1}$ where Z' is disjoint from Z, and where Z and Z' witness the non-normality of $\mathbb{N}^{\omega_1}$. We use the above to get a relationship between witnesses to the non-normality of $\mathbb{N}^{\omega_1}$ and discrete subsets of $\mathbb{N}^{\omega_1}$, as well as give a pair of disjoint countable closed discrete subsets of $\mathbb{N}^{\omega_1}$ which can not be separated by open sets having disjoint closures. A.H. Stone gave two closed disjoint homeomorphic subsets of $\mathbb{N}^{\omega_1}$ failing to have an open separation. We expand on the property that his witnesses are homeomorphic by showing that for any closed set $Z \subset \mathbb{N}^{\omega_1}$ if Z has a non-Lindelöf boundary, then there exists a closed set $Z' \subset \mathbb{N}^{\omega_1}$ where Z and Z' are disjoint, homeomorphic, and fail to have an open separation. (Received July 30, 2011)

1073-54-142 **Ronnie Levy*** (rlevy@gmu.edu). *Questions on strong ω-boundedness.* Preliminary report.

A Tychonoff space X is *strongly ω-bounded* if the closure in X of every σ-compact subset of X is compact. We discuss this property and pose some questions relating to it. (Received July 31, 2011)

1073-54-150 **Richard E. Hodel*** (hodel@math.duke.edu), Box 90320, Mathematics Department, Duke University, Durham, NC 27708. *Matroid theory, topology, logic: What do they have in common?*

Fundamental concepts in each of the above branches of mathematics can be axiomatized in terms of a closure operator that satisfies certain additional conditions. We take a slightly different approach by using a consequence relation (taken from logic) and denoted by δ (taken from topology). Informally, x δ A states that x is near A. Here is a preview of the way this is interpreted in various settings:

linear algebra: the vector x is a linear combination (or an affine combination) of vectors in A. graph theory: x is a edge with vertices u and v and there is a path P $\subset$ A that joins u and v. topology: x is in A or x is a limit point of A. logic: statement x follows for the axiom system A by the laws of logic.

We prove theorems that apply to all three branches and also give examples and theorems in each specific area. For example, in topology we focus on the question "When do countable sets suffice?" Cryptomorphisms are emphasized throughout. (Received July 31, 2011)

1073-54-153 **Raushan Z Buzyakova*** (rzbouzia@uncg.edu), Department of Mathematics and Statistics, University of North Carolina at Greensboro, Greensboro, NC 27412, and **Alex Chigogidze** (alex.chigogidze@csi.cuny.edu), 2800 Victory Blvd, College of Staten Island, Staten Island, NY 10314. *Fixed and Periodic Points of Single/Multi-valued Functions on Euclidean Spaces.*

We will discuss how the set of fixed/periodic points of a given map defined on a subset of a Euclidean space is related to the set of such points in various continuous extensions of the map. (Received July 31, 2011)

1073-54-189 **Akira Iwasa*** (iwasa@uscb.edu), One University Boulevard, Bluffton, SC 29909. *Preserving the convergence of a sequence to a set under Cohen extensions.* Preliminary report.

A sequence is said to converge to a set, provided every neighborhood of the set contains all but finitely many terms of the sequence. We investigate under what conditions the sequence still converges to the set after adding Cohen reals. (Received August 01, 2011)

1073-54-199 **John S Kulesza*** (jkulesza@gmu.edu), George Mason University, Mathematics Department, MSN 3F2, 4400 University Drive, Fairfax, VA 22030, and **Keith Fox** (kfox@gmu.edu), George Mason University, Mathematics Dept, MSN 3F2, 4400 University Drive, Fairfax, VA 22030. *Rim-finite Separable Metric Spaces.* Preliminary report.

It has been known that rim-n separable metric spaces which are arc free can have positive topological dimension but the smallest known value of n for which which this happened was n = 72. (A topological space is rim-n if it has a basis of open sets, each of which have at most n boundary points.)

We improve on this result by showing that for any n greater than 2, there is a rim-n subset of the plane which is arc free and connected (thus one-dimensional). We complete the picture by showing that a rim-2 separable metric space with dimension at least one must contain an arc. (Received August 01, 2011)

1073-54-218 **Andrzej A. Szymanski*** (andrzej.szymanski@sru.edu). *Some non-normality points.* Preliminary report.

A point p in a space X is called a non-normality point of X if the space X is normal and the subspace X-p is not normal. We discuss the existence of non-normality points in compact Hausdorff spaces. We utilize the topological version of Fodor's Pressing Down Lemma to exhibit new instances of non-normality points. (Received August 01, 2011)

1073-54-233 **Wanjun Hu*** (Wanjun.Hu@asurams.edu), Department of Math & CS, Albany State University, Albany, GA 31705. *Other Applications of Forcing Theory.* Preliminary report.

Forcing theory has major applications in logic and general topology. In this talk, we look at applications to other areas, especially non science area.

1. Decomposability of Partially Defined Boolean Functions. Discrete Applied Mathematics 62, 1995, 51-75 (with E. Boros, V. Gurvich, T. Ibaraki, and A. Kogan). (Received August 02, 2011)

1073-54-242 **Peter J Nyikos*** (nyikos@math.sc.edu), Dept. of Mathematics, University of South Carolina, Columbia, SC 29208, and **Heikki Junnila**. *Utterly normal spaces.* Preliminary report.

A space is *utterly normal* if it has a magnetic base system. This is defined as a family of neighborhood bases $\mathcal{B}(x)$ for each point x with the following property: If $B_x \in \mathcal{B}(x)$ and $B_y \in \mathcal{B}(y)$ and $B_x \cap B_y \neq \emptyset$ then either x is in the closure of B_y or y is in the closure of B_x.

It follows from the Borges criterion that every utterly normal space is monotonically normal, but the question of whether the converse is true has been an open problem since the concept was introduced in Peter Collins's article "Monotone normality" [Topology and its Appl. 74 (1996) 179–198].

In fact, we do not even know whether every M_0 space is utterly normal. Nor do we know whether every utterly normal space is hereditarily normal, unlike the case with monotonically normal spaces.

On the other hand, we do know that P-spaces, suborderable spaces, compact monotonically normal spaces, Lasnev spaces, and F_σ-metrizable stratifiable spaces are utterly normal. Other properties will be mentioned as time permits. (Received August 02, 2011)

1073-54-245 **Ziqin Feng*** (fengz2@muohio.edu), Miami Unviersity, Department of Mathematics, Oxford, OH 45056. *Function Spaces and Structure Mechanism.*

In this talk, I will present some recent progress in the research of structure mechanism and function spaces under point-wise topology. (Received August 02, 2011)

1073-54-256 **Strashimir G Popvassilev** (spopvassilev@ccny.cuny.edu), Department of Mathematics, The City College of New York, NAC 8/133 Convent Ave at 138th Street, New York, NY 10031, and **John E Porter*** (ted.porter@murraystate.edu), Department of Mathematics & Statistics, Faculty Hall 6C, Murray, KY 42071. *Monotonically star-P spaces.* Preliminary report.

We define monotone properties using stars of coverings. This relates to work of V. Tkachik, R. Wilson, J. van Mill, O. Alas, L. Junqueira, M. Matveev and others who generalized the D-space property of E. van Douwen and E. Michael. Given a property P, we call a topological space X monotonically star-P if one can assign to each open cover $\mathcal{U}$ a subspace $s(\mathcal{U})$ of X with property P in such a way that $\mathrm{Star}(s(\mathcal{U}),\mathcal{U}) = X$ and if $\mathcal{V}$ refines $\mathcal{U}$ then $s(\mathcal{U}) \subset s(\mathcal{V})$. Countably compact separable spaces are monotonically star-finite. Each ω-bounded, monotonically star-finite space is compact. There is a sequentially compact, monotonically star-finite space that is not compact. There is a countably compact space that is not monotonically star-compact. If X is a regular T_1 space with a weak P-point p then $X \setminus \{p\}$ and X are not monotonically star-finite. Proto-metrizable spaces are monotonically

star-closed-and-discrete, but stationary sets of regular uncountable cardinals are not monotonically star-closed-and-discrete. Monotonically star-closed-and-discrete GO-spaces are paracompact. Monotonically star-finite GO-spaces are compact and first countable. (Received August 02, 2011)

55 ► Algebraic topology

1073-55-161 **Candice R Price*** (candice.r.price@gmail.com). *A discussion on the knot Floer homology of $(2,p)$-torus links and clasp knots.* Preliminary report.

In *On the skein exact sequence for knot Floer homology*, Peter Ozsváth and Zoltán Szabó proved that there is a long exact sequence relating three knot diagrams that differ at a single crossing. We call these diagrams a skein triple denoted, (K_+, K_-, K_0). After looking at applications of this theorem, the following question arose: "What can be said about particular families of knots when discussing the oriented skein exact sequence?"

I will give a brief description of knot Floer homology and discuss how the skein exact sequence can be used to calculate the homology of $(2,p)$-torus links and clasp knots. (Received July 31, 2011)

57 ► Manifolds and cell complexes

1073-57-1 **Tim Cochran** and **Shelly Harvey***, Department of Mathematics, MS #136, Rice University, 6100 Main St., Houston, TX 77005, and **Peter Horn**. *4-Dimensional Equivalence Relations on Knots.*

A knot is an embedded circle in $\mathbb{R}^3$. It is slice if it is the intersection of a 2-dimensional sphere in $\mathbb{R}^4$ with the standard $\mathbb{R}^3 \subset \mathbb{R}^4$. Initially, it was thought that all knots were slice. In the 60's, Murasugi and Fox-Milnor proved that many knots are not slice. Using the notion of sliceness, one can define an equivalence relation on knots called concordance. Moreover, the set of equivalence classes of knots forms an abelian group called the knot concordance group. This group plays an important role in the study of 3- and 4-dimensional manifolds. In this talk, we will give a historical overview of knot concordance and also describe some of our new work on the knot concordance group as described below.

We will define a new filtration of the knot concordance group, called the n-positive filtration. This is a refinement of the n-solvable filtration defined by Cochran-Orr-Teichner in the late 90's. We show that, unlike the n-solvable filtration, the n-positive filtration restricts to give a non-trivial filtration on an important subgroup of the knot concordance group called the group of topologically slice knots. The methods we use are Heegaard-Floer d-invariants and Casson-Gordon signature invariants. (Received July 27, 2011)

1073-57-11 **Morwen Thistlethwaite** and **Anastasiia Tsvietkova***, tsvietkova@math.utk.edu. *An alternative approach to hyperbolic structures on link complements.*

As a result of Thurston's Hyperbolization Theorem, many 3-manifolds have a hyperbolic metric or can be decomposed into pieces with hyperbolic metric (W. Thurston, 1978). In particular, Thurston demonstrated that every knot in S^3 is a torus knot, a satellite knot or a hyperbolic knot and these three categories are mutually exclusive. It also follows from work of Menasco that an alternating link represented by a prime diagram is either hyperbolic or a $(2,n)$-torus link.

A new method for computing the hyperbolic structure of the complement of a hyperbolic link, based on ideal polygons bounding the regions of a diagram of the link rather than decomposition of the complement into ideal tetrahedra, was suggested by M. Thistlethwaite. The talk will introduce the basics of the method. Some applications will be discussed, including a surprising rigidity property of certain tangles, a new numerical invariant for tangles, a number field that is an invariant of a hyperbolic link, and an algorithm for computing hyperbolic volume. (Received June 1, 2011)

1073-57-52 **Anar Akhmedov*** (Akhmedov@Umn.edu). *Simply connected symplectic Calabi-Yau 6 manifolds.* Preliminary report.

We construct simply connected symplectic Calabi-Yau 6 manifolds by applying Gompf's symplectic connected sum operation along T^4. We also produce the first examples of simply connected symplectic Calabi-Yau and non-Calabi-Yau 6 manifolds via coisotropic Luttinger surgery. (Received July 22, 2011)

1073-57-64 **John A Baldwin*** (baldwinj@math.princeton.edu), Fine Hall, Washington Rd., Princeton, NJ 08544-1000, and **David Shea Vela-Vick** and **Vera Vertesi**. *On the equivalence of transverse knot invariants in knot Floer homology.*

Using the grid diagram formulation of knot Floer homology, Ozsvath, Szabo and Thurston defined an invariant of transverse knots in the tight contact 3-sphere. A while later, Lisca, Ozsvath, Stipsicz and Szabo defined an invariant of transverse knots in arbitrary contact 3-manifolds by way of open book decompositions. It has long been thought that these invariants agree where they overlap. We prove this fact by defining yet another invariant of transverse knots and showing that this third invariant agrees with the two invariants mentioned above. This is joint work with Vera Vertesi and David Shea Vela-Vick. (Received July 25, 2011)

1073-57-75 **Lenhard Ng*** (ng@math.duke.edu), Mathematics Department, Duke University, Durham, NC 27708. *Transverse knots and naturality in knot Floer homology.* Preliminary report.

Transverse knots in $\mathbb{R}^3$ are knots that are transverse to the standard contact structure given by $\ker(dz - y\,dx)$. I will survey what is known about classifying transverse knots. In particular, I'll describe some new preliminary work with Dylan Thurston, in which we use naturality for knot Floer homology to strengthen the grid invariant of transverse knots. This allows us to distinguish certain transverse examples of Birman and Menasco, and has consequences for the transverse mapping class group. (Received July 27, 2011)

1073-57-76 **Eric J Rawdon*** (ejrawdon@stthomas.edu), Dept of Mathematics, University of St. Thomas, Saint Paul, MN 55105. *Knotted Arcs.* Preliminary report.

Some proteins have been classified recently as being knotted. However, proteins have free ends and knotting, traditionally, has only been defined formally for closed curves. How should we define the existence of knotting within open chains? Once we settle on a definition, we can search for smallest knotted arcs within knotted open and closed chains. We discuss generating polymer models and show recent results for classifying the knotting within models and within proteins. This is joint work with Ken Millett, Andrzej Stasiak, and Joanna Sulkowska. (Received July 27, 2011)

1073-57-79 **Tamás Kálmán*** (kalman@math.titech.ac.jp). *A new type of combinatorics in knot theory.*

Given a bipartite graph G, I will outline the construction of its root polytope Q_G and that of its two hypertree polytopes which are (essentially) cross-sections of Q_G. I will explain how these objects are related to low-dimensional topology on two fronts: A) If the plane bipartite graph G is the Seifert graph of the special alternating link L_G, then the Homfly polynomial of L_G contains the common h-vector of all triangulations of Q_G. This is joint work with Hitoshi Murakami. B) The hypertree polytopes of a plane bipartite graph are recovered as the Euler characteristic of certain sutured Floer homology groups. This result is joint with András Juhász and Jake Rasmussen. (Received July 27, 2011)

1073-57-88 **Joan E. Licata***, School of Mathematics, Simonyi Hall, Einstein Dr., Institute for Advanced Study, Princeton, NJ 08540, and **Joshua Sabloff**. *Rational Classical Invariants in Seifert Fibered Spaces.*

We consider Legendrian knots in Seifert fibered spaces equipped with transverse, S^1-invariant contact structures, and we represent such knots combinatorially using labeled diagrams. When the knot has finite homological order, an analogue of Seifert's algorithm enables the computation of the rational Thurston-Bennequin and rotation numbers from numerical data on the labeled diagram. (Received July 27, 2011)

1073-57-94 **William H. Kazez*** (will@math.uga.edu), Department of Mathematics, University of Georgia, Athens, GA 30606, and **Rachel Roberts**. *Right-veering automorphisms of surfaces and overtwisted contact structures.* Preliminary report.

The Giroux coursepondence between contact structures on 3-manifolds and equivalence classes of automorphisms of surfaces leads to a natural question: What do you have to know about a single automorphism to understand if the corresponding contact structure is tight? Starting with work of Gabai, we give new counterexamples to a conjecture of Honda-Kazez-Matic. (Received July 28, 2011)

1073-57-114 **Jason Cantarella** and **Elizabeth Denne***, Department of Mathematics & Statistics, Smith College, Northampton, MA 01063, and **John McCleary**. *Squarepegs and Inscribed Polygons.* Preliminary report.

Given any Jordan curve in the plane, are there four points on the curve which are the vertices of square? This talk will give an update on our progress on this problem, as well as other results about polygons inscribed in simple closed curves in dimensions 3 and higher. (Received July 29, 2011)

1073-57-116 **David Gay** and **Thomas E Mark***, tmark@virginia.edu. *Lefschetz fibrations, convexity, and symplectic surgeries.*

A sequence of Dehn twists on a surface with boundary describes a Lefschetz fibration W whose boundary has a natural open book structure. The monodromy of the open book is the composition ϕ of the Dehn twists, but if ϕ admits another expression as a composition of twists then we get another Lefschetz fibration W' bounding the same open book. This leads to cut-and-paste operations on 4-manifolds, where W is replaced by W'. Under appropriate circumstances this operation may be performed symplectically, and this leads to a new proof that rational blowdowns are symplectic as well as some potentially useful new symplectic surgeries. (Received July 29, 2011)

1073-57-122 **Angela Angeleska**, **Natasa Jonoska** and **Masahico Saito*** (saito@usf.edu). *Template guided DNA recombination model via spatial graphs.*

We describe a model of RNA template guided recombination of DNA in certain kinds of ciliates. Genome rearrangement processes are modeled by 4-regular spacial graphs with rigid vertices, called assembly graphs. The rearranged DNA segments are modeled by certain types of paths in the assembly graphs called polygonal paths. The minimum number of such polygonal paths is discussed.

The recombination processes happen in certain succession, possibly with some recombination events performed at the same time, but others in a prescribed order. We use a partial order on DNA molecules that models this situation, and apply it to experimental data to obtain possible intermediate molecules in gene assembly. (Received July 29, 2011)

1073-57-137 **Yuanan Diao*** (ydiao@uncc.edu), 11908 Three Vistas Ct, Charlotte, NC 28277, and **Gabor Hetyei**. *Relative Tutte Polynomials for Colored Graphs and Virtual Knot Theory.*

In an earlier work, we introduced the concept of a relative Tutte polynomial of colored graphs. We showed that this relative Tutte polynomial can be computed in a way similar to the classical spanning tree expansion used by Tutte in his original paper on this subject. We showed that the Kauffman bracket polynomial (hence the Jones polynomial) of a virtual knot can be computed from the relative Tutte polynomial of the face graph of any given projection of the virtual knot, with some suitable variable substitutions. In this talk, we show that the special formulation of Tutte polynomial in the case of a tensor product of two colored graphs by Brylawski can be extended to the case of the relative Tutte polynomials. This allows fast computations of the Jones polynomials of virtual knots obtained by repeated tangle operations. (Received July 30, 2011)

1073-57-143 **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 July 31, 2011)

1073-57-146 **Olga Plamenevskaya*** (olga@math.sunysb.edu), Department of Mathematics, Stony Brook University, Stony Brook, NY 11794. *Knot Floer homology and tight contact structures.*

Ozsvath-Szabo contact invariants can be used in several different ways to establish tightness of contact 3-manifolds. For example, contact surgery techniques and examination of cobordism maps on Heegaard Floer homology was used by Lisca-Stipsicz to construct tight contact structures on many Seifert fibered spaces. For an alternative approach, we focus on the relation of the contact invariants and the knot Floer homology of the binding of an open book compatible with the contact structure. We show that if an open book decomposition (Y,K) induces a contact structure with non-vanishing Ozsvath-Szabo invariant, then all manifolds obtained by sufficiently large surgeries on K carry tight contact structures. This produces tight contact structures on some hyperbolic manifolds without taut foliations. (Joint with M. Hedden.) (Received July 31, 2011)

1073-57-158 **Y. Diao**, Dept. of Math. and Stat., UNCC, Charlotte, NC 28223, **C. Ernst*** (claus.ernst@wku.edu), Dept. of Math. and Comp. Science, WKU, Bowling Green, KY 42101, **A. Montemayor**, Dept. of Math. and Comp. Science, WKU, Bowling Green, KY 42101, and **U. Ziegler**, Dept. of Math. and Comp. Science, WKU, Bowling Green, KY 42101. *Generating Random Polygons in Spherical Confinement I.*

We discuss a fast algorithm or method that generates confined equilateral random polygons in spherical confinement where the polygons start and end at the center of the confinement sphere. For a polygon the placement of each vertex is selected based on the true theoretical probability distribution of its location, and thus we can prove that we do generate polygons in our sample space with uniform probability. (Received July 31, 2011)

1073-57-166 **Y. Diao**, **C. Ernst**, **A. Montemayor** and **U. Ziegler*** (uta.ziegler@wku.edu). *Generating Random Polygons in Spherical Confinement II.* Preliminary report.

In a continuation of the talk introducing the algorithm to generated confined polygons we now address questions regarding the runtime of the algorithm and the effect of numerical error on the actual shape of the polygon generated. We also discuss and analyze various properties of the polygons that were generated. (Received July 31, 2011)

1073-57-173 **Kenneth L Baker*** (kenken@math.miami.edu), Department of Mathematics, 515 Ungar, University of Miami, Coral Gables, FL 33146, and **Dorothy Buck** (d.buck@imperial.ac.uk), Department of Mathematics, South Kensington Campus, Imperial College London, London, SW7 2AZ, England. *Sites of Rational Tangle Replacements.* Preliminary report.

Alterations to DNA by certain enzymes may be modeled as rational tangle replacements (RTR) on the tangle defined by the DNA axis. Through double branched covers, the Montesinos Trick translates the problem of which DNA conformations may be related by a RTR into the problem of which 3-manifolds may be related by Dehn surgery on a knot. However, since two different tangles may have the same double branched cover, it is a more subtle question to understand where these RTRs may occur.

We will discuss these issues focusing upon RTRs between two-bridge links and RTRs between rational tangles as these are the more biologically relevant situations. In certain cases we will give the full picture of where these RTR occur; in other cases we will give a conjectural picture. (Received August 01, 2011)

1073-57-182 **Kenneth C Millett***, Department of Mathematics, University of California, Santa Barbara, Santa Barbara, CA 93106. *Geometric and Topological Properties of Open and Close Polygons.* Preliminary report.

Properties of open and closed polygons, depending on geometry, based on rigorous proofs and numerical models will be discussed. These includethe presence and scale of knots and slipknots, a focus of this talk. (Received August 01, 2011)

1073-57-185 **Joshua Sabloff*** (jsabloff@haverford.edu), Department of Mathematics, Haverford College, 370 Lancaster Ave., Haverford, PA 19041, and **Lisa Traynor** (ltraynor@brynmawr.edu), Department of Mathematics, Bryn Mawr College, 101 North Merion Ave., Bry Mawr, PA 19010. *Obstructions to Lagrangian Cobordisms between Legendrian Submanifolds.*

Legendrian knots lie at the intersection of knot theory and contact topology, so one might hope to gain insight into the geometry and geography of Legendrian knots by adapting questions and techniques from the smooth to the contact setting. In smooth knot theory, for example, one might study the 4-ball genus of a knot or concordance between knots. For a Legendrian submanifold in a contact manifold X, this translates to finding Lagrangian cobordisms between Legendrian submanifolds in the symplectization $\mathbb{R}\times X$. I will discuss obstructions to two Legendrian submanifolds being Lagrangian cobordant and, in particular, obstructions to a Legendrian submanifold having a Lagrangian cap, i.e. being null-cobordant. I will produce these obstructions using the technique of generating families and will also explore how Lagrangian cobordisms illuminate the geometric meaning and TQFT-like structure of generating family invariants. (Received August 01, 2011)

1073-57-190 **Helen M Wong*** (hwong@carleton.edu), 1 N College St, Northfield, MN 55057, and **Francis Bonahon**. *Representations of the Kauffman Skein Algebra.* Preliminary report.

We begin with an overview of the Kauffman skein algebra. Originally defined combinatorially following the Kauffman bracket polynomial, the Kauffman skein algebra can also be understood as a quantization of the representation variety of surface groups into $PSL_2(\mathbb{C})$ using the Weil-Petersson-Goldman Poisson structure. We

make use of this latter interpretation to construct representations of the Kauffman bracket skein algebra and discuss a conjectured classification of them. (Received August 01, 2011)

1073-57-200 **Taylor E Martin*** (taylor.coon@gmail.com), Rice University Dept of Mathematics, 6100 S. Main Street, Houston, TX 77005. *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 its Seifert matrix looks like that of a slice knot, called algebraically slice. However, very little is known for links. In this talk, we will completely classify 0-solvable links. (Received August 01, 2011)

1073-57-211 **Bob Davis** and **Hugh N Howards***, Dept of Math, Wake Forest Univ, Winston-Salem, NC 27109, and **Jonathan Newman** and **Jason Parsley**. *Convex Brunnian links in higher dimensions.*

Howards generalized a result of Freedman and Skora from dimension 3 to show that no Brunnian link of any dimension can be constructed using round spheres, and furthermore, the Borromean rings are the only Brunnian link (of dimension 3) that can be built using three convex components. This paper proves that convex Brunnian links exist for every dimension $n \geq 3$ by constructing explicit examples. These examples are three-component links which are higher-dimensional generalizations of the Borromean rings. (Received August 01, 2011)

1073-57-216 **Matt Mastin*** (mmastin@math.uga.edu), Department of Mathematics, University of Georgia, Athens, GA 30602. *Symmetries of Composite Knots and Links.* Preliminary report.

We will discuss the JSJ-decompositions of knot and link complements in S^3 and how they can be utilized to tabulate composite knots and links as well as compute the intrinsic symmetries of the composites. This talk will focus on computing the symmetries of a composite knot or link from the symmetries of its prime factors. (Received August 01, 2011)

1073-57-219 **Joshua M. Sabloff** and **Clayton Shonkwiler*** (cshonkwi@haverford.edu), Department of Mathematics, University of Georgia, Athens, GA 30602, and **David Shea Vela-Vick**. *Rulings and augmentations for bordered Legendrian knots.* Preliminary report.

We generalize the correspondence between rulings of Legendrian knots and augmentations of their Chekanov–Eliashberg DGAs to the case of bordered Legendrian knots. Since the non-existence of a ruling is a local phenomenon, this seems to provide a more natural approach to understanding rulings. (Received August 01, 2011)

1073-57-220 **Frederick R. Cohen**, **Rafal Komendarczyk** and **Clayton Shonkwiler***, Department of Mathematics, University of Georgia, Athens, GA 30602. *Homotopy periods of link maps and Milnor's invariants.* Preliminary report.

Given a parametrized n-component link L in $\mathbb{R}^3$, the parametrization produces a natural evaluation map e_L from the product of n circles to the configuration space of n distinct points in $\mathbb{R}^3$. In the $n = 2$ case, the classical fact that the linking number of L equals the degree of its Gauss map implies that there is a one-to-one correspondence between link homotopy classes of 2-component links and homotopy classes of maps from the product of two circles to the configuration space of two points in $\mathbb{R}^3$. Koschorke conjectured that the equivalent result holds for arbitrary n and proved that this conjecture is true for Brunnian links. In this talk I will give an explicit description of Koschorke's correspondence for Brunnian links which leads to a novel characterization of the set of Brunnian links and to geometric interpretations of Milnor's μ-invariants for string links. (Received August 01, 2011)

1073-57-226 **Rumen Zarev*** (rzarev@math.berkeley.edu). *Dividing sets, contact structures, and TQFTs.* Preliminary report.

One can enrich the category of 3-dimensional cobordisms between surfaces in different ways. One example is to look at surfaces with dividing sets (multi-curves dividing a surface into "positive" and "negative" parts), and 3-manifolds with contact structures.

One TQFT-like invariant for this category is the contact invariant EH valued in sutured Floer homology. It turns out that one can strengthen this to an A_∞-invariant, using bordered sutured Floer homology. We can use this strengthening to show that the category of contact structured is closely related to the bordered category associated to a surface. (Received August 02, 2011)

60 ► Probability theory and stochastic processes

1073-60-159 **Yuanan Diao**, **Claus Ernst** and **Anthony G Montemayor***, anthony.montemayor477@topper.wku.edu, and **Uta Ziegler**. *Generating Random Polygons in Spherical Confinement III.*

The algorithm discussed in the two prior talks for generating closed, equilateral, random walks in spherical confinement relies upon the walk beginning and ending at the center of the confinement sphere. To sample all closed, equilateral, random walks under spherical confinement we need to extend this algorithm to allow an arbitrary starting point within the confinement sphere. Using a straight-forward geometric argument we present such an extension and its consequences. (Received July 31, 2011)

62 ► Statistics

1073-62-4 **Seth M. Sullivant*** (smsulli2@ncsu.edu), Department of Mathematics, North Carolina State University, Raleigh, NC. *Algebraic statistics.*

Algebraic statistics advocates polynomial algebra as a tool for addressing problems in statistics and its applications. This connection is based on the fact that most statistical models are defined either parametrically or implicitly via polynomial equations. The idea is summarized by the phrase "Statistical models are semialgebraic sets". I will try to illustrate this idea with two examples, the first coming from the analysis of contingency tables, and the second arising in computational biology. I will try to keep the algebraic and statistical prerequisites to an absolute minimum and keep the talk accessible to a broad audience. (Received July 30, 2011)

65 ► Numerical analysis

1073-65-29 **James V Lambers*** (James.Lambers@usm.edu), 118 College Dr #5045, Hattiesburg, MS 39406-0001. *Solution of Time-Dependent PDE Through Component-wise Approximation of Matrix Functions.* Preliminary report.

Krylov subspace spectral (KSS) methods are high-order accurate, explicit time-stepping methods with stability characteristic of implicit methods. This "best-of-both-worlds" compromise is achieved by computing each Fourier coefficient of the solution using an individualized approximation, based on techniques from "matrices, moments and quadrature" for computing bilinear forms involving matrix functions. In this talk, it will be shown how this approach can be applied to nonlinear PDE. (Received July 11, 2011)

1073-65-229 **Padmanabhan Seshaiyer*** (pseshaiy@gmu.edu), 4400 University Drive, MS 3F2, Department of Mathematical Sciences, George Mason University, Fairfax, VA 22030. *Applications of differential equations for fluid-structure interaction problems in biological systems.* Preliminary report.

This work will present the results from projects that evolved from multidisciplinary applications of differential equations for fluid-structure interaction problems in biological systems. Specifically, numerical methods for efficient computation of nonlinear interaction for coupled differential equation models that arise from biological applications will be presented. Some theoretical results that validate the reliability and robustness of the proposed computational methodology will also be presented. Moreover, we will also discuss how such projects can provide opportunities for students to employ transformative research in areas that bridge the gap between mathematical and biological sciences. (Received August 02, 2011)

68 ► Computer science

1073-68-23 **Saugata Basu** and **Thierry Zell*** (thierry.zell@lr.edu). *A real analogue of Toda's theorem.*

Toda's theorem in classical computational complexity theorem states that decision problems belonging to the polynomial hierarchy can be solved in polynomial time if given access to an oracle solving problems from Valiant's class $\#P$. We prove an analogue of Toda's result in the context of the Blum-Shub-Smale model of computation over the reals. If the analogous classes are straightforward to define, the proof is drastically different from Toda's own; it is topological in nature, and relies on the computation of a descent spectral sequence. (Received June 29, 2011)

1073-68-234 **Chris Barrett**, **Jiangzhou Chen**, **Stephen Eubank**, **Achla Marathe**, **Madhav Marathe** and **Anil Kumar Vullikanti*** (vsakumar@vt.edu). *Economics of Epidemic Planning and Response.*

A fundamental challenge in public health decision making is to design cost-effective interventions to control the spread of diseases. Interventions include a combination of vaccinations, anti-virals and quarantining, and choosing effective interventions within a given budget is a challenging stochastic optimization problem. Different kinds of targeted heuristics have been proposed, including those based on degree and demographics such as age. We use a measure called vulnerability to design targeted interventions, and find it is much more effective than other heuristics. We also use this measure to develop efficient algorithms for protecting a selected sub-population. (Received August 02, 2011)

82 ► Statistical mechanics, structure of matter

1073-82-3 **Benjamin B. Brubaker*** (brubaker@math.mit.edu), Department of Mathematics, Massachusetts Institute of Technology, Cambridge, MA 02139. *Square ice, symmetric functions, and their connections to automorphic forms.*

We will discuss an example of a two-dimensional lattice model called square ice, which has an elementary combinatorial description. This model will be used to generate Schur polynomials, a particularly nice class of symmetric functions. We explain how to prove that functions on square ice are symmetric using a beautiful technique of Rodney Baxter based on the Yang-Baxter equation.

Finally, we discuss the connection between Schur polynomials, ice models, and automorphic forms. In brief, the Fourier coefficients of certain automorphic forms (known as Eisenstein series) on the general linear group are expressible as Schur polynomials. At the conclusion, we'll speculate about the wider use of statistical models in studying automorphic forms.

No assumptions on previous acquaintance with any of the above topics will be made in the talk, and a large portion should be accessible to a wide audience including undergraduates. This is based on joint work with Daniel Bump and Solomon Friedberg. (Received July 29, 2011)

91 ► Game theory, economics, social and behavioral sciences

1073-91-121 **Peng Sun*** (psun@duke.edu), 100 Fuqua Drive, Box 90120, Durham, NC 27708, and **de Vericourt Francis**, **Shouqiang Wang** and **Liu Yang**. *Decentralized resource allocation to control an epidemic.*

We present two game theoretic resource allocation models on epidemic control. First, we develop a two-period multivariate Reed-Frost model to represent the spread of the epidemic within and across countries at its onset, which captures three critical sources of uncertainty: the number of initial infections, the spread of the disease, and drug efficacy. We show that for small probabilities of between-country infections, the underlying game is supermodular, Nash equilibrium exists, and there is a unique Pareto optimal equilibrium among all existing equilibria. We also identify conditions under which the optimal centralized solution constitutes a Pareto improvement over decentralized equilibria.

The second model examines how two countries allocate resources to minimize the total number of infectives in their respective populations over the entire time horizon. Assuming the initial number of infectives is small, we show in that selfish countries always allocate their resources to bring the effective reproduction ratio below one and avoid a major outbreak. When a major outbreak is avoidable, we further identify necessary and sufficient conditions under which the individual allocation decisions minimize the total number of infectives in the whole population. (Received July 29, 2011)

1073-91-141 **Mark Gersovitz*** (gerso@att.net), Department of Economics, Johns Hopkins University, Baltimore, MD 21218. *Disinhibition and Immiserization in a Model of Susceptible-Infected-Susceptible (SIS) Diseases.*

Infectious diseases induce externalities in private choices about prevention and therapy. An improvement in either the technology of prevention or therapy may lead private agents to decrease their preventive or therapeutic efforts, a phenomenon termed disinhibition by epidemiologists. If governments cannot or do not adopt interventions to internalize these externalities, a technological improvement may even lead to disinhibition so extreme that the

infection rate rises. A rise in the infection rate is a necessary but not sufficient condition for immiserization, the paradoxical fall in welfare consequent on a technological improvement. These issues are investigated in a model in which susceptibles may become infected and infecteds may recover to be again susceptible. Conditions are provided for when the infection rate can rise depending on whether the improvement is to the technology of prevention or therapy and at whom prevention or therapy is targeted, as well as other parameters of the model. Results are provided for a general formulation and for a special functional form. (Received July 31, 2011)

1073-91-183 **Frederick Chen*** (chenfh@wfu.edu). *Equilibrium, Efficiency, and Epidemics in a Game-Theoretic Model of Public Avoidance.* Preliminary report.

A mathematical model of infectious disease transmission in which people can engage in public avoidance behavior is considered. The tools of game theory are employed to analyze individuals' decisions regarding their level of public avoidance. It is shown that the number of Nash equilibria depends on properties of the contact function. When multiple Nash equilibria coexist, the severity of an epidemic and social welfare depend on which equilibrium is played. In general, the level of public avoidance in a Nash equilibrium differs from the socially optimal level. (Received August 01, 2011)

92 ► Biology and other natural sciences

1073-92-5 **Kanadpriya Basu*** (basuk@mailbox.sc.edu), 1523 Greene Street, Leconte College, Dept. of Mathematics, Columbia, SC 29208, and **Xingfeng Liu**. *Substrate sequestration in a multisite phosphorylation system produces bi-stability.(Preliminary Report).* Preliminary report.

Cascades of coupled phosphorylation/dephosphorylation cycles,such as mitogen-activated protein kinase(MAPK) pathways, integrate external stimuli and propagate signals from plasma membrane to nucleus. A typical, three-stage cascade consists of MAPK, MAP2K and MAP3K.MAP2K is activated by MAP3K at cell membrane by an addition of a phosphate group and consequently the interior protein MAPK in the cell (near nucleolus membrane) is phosphorylated by activated MAP2K on two conserved threonine and tyrosine residues. Activated MAPK then sends some signal in nucleus to take the stand for the external signal. Various phosphatases undo these phosphorylations. Here we considered various mathematical models to model this kind of system, which involve multisite phosphorylation system with regulated substrate sequestration. Our models demonstrate that substrate sequestration in combination of multisite phosphorylation can produce robust switch-like and bi-stability. (Received March 25, 2011)

1073-92-27 **Nicoleta Tarfulea*** (ntarfule@purduecal.edu), Department of Mathematics, Purdue University Calumet, 2200 169th Street, Hammond, IN 46323. *A mathematical Model for HIV Treatment with Time-varying Antiretroviral Therapy.*

We present a mathematical model to investigate theoretically and numerically the effect of immune effectors, such as the cytotoxic lymphocyte (CTL), in modeling HIV pathogenesis during primary infection. Additionally, by introducing drug therapy, we assess the effect of treatments consisting of a combination of several antiretroviral drugs. A periodic model of bang-bang type and a pharmacokinetic model are employed to estimate the drug efficiencies. Nevertheless, even in the presence of drug therapy, ongoing viral replication can lead to the emergence of drug-resistant virus variances. Thus, by including two viral strains, wild-type and drug-resistant, we show that the inclusion of the CTL compartment produces a higher rebound for an individual's healthy helper T-cell compartment than does drug therapy alone. We investigate numerically how time-varying drug efficacy due to drug dosing regimen and/or suboptimal adherence affects the antiviral response and the emergence of drug resistance. Moreover, we characterize successful drugs or drug combination scenarios for both strains of virus. (Received July 06, 2011)

1073-92-46 **L. R. Ritter*** (lritter@spsu.edu), Southern Polytechnic State University, 1100 S. Marietta Pkwy, Dept. of Mathematics, Marietta, GA 30060, and **A Ibragimov** and **J Walton**. *Stability analysis of a reaction-diffusion system modeling atherogenesis.*

Atherogenesis refers to the initiation of atherosclerosis–a disease characterized by the accumulation of lipid laden immune cells and cellular debris in the walls of large muscular arteries. Chronic inflammation is a principal component of the disease process which involves the accumulation and oxidation of low density lipoproteins (LDL) within the arterial wall and the inability of macrophages to perform normally in the presence of oxidized LDL. We present a reaction-diffusion model involving chemotaxis of certain bio-chemical processes involved in the disease, and propose that initiation of cellular aggregation can be viewed as a mathematical instability. We

perform stability analyses accounting for immune cell subspecies interactions, differing roles of immune cells with respect to the components of an emerging lesion, the effects of anti-oxidants, and boundary transport. (Received July 20, 2011)

1073-92-65 **Folashade B Agusto*** (fbagusto@gmail.com), Department of Mathematics, Austin Peay State University, Clarksville, TN 37040, and **Abba B Gumel** (gumelab@cc.umanitoba.ca), Department of Mathematics, University of Manitoba, Winnipeg, Manitoba, R3T 2N2, Canada. *Quantitative Analysis for a Model for the Transmission Dynamics of Low and Highly Pathogenic Avian Influenza.* Preliminary report.

A deterministic model for the transmission dynamics of two strains of avian influenza is designed and rigorously analyzed. The model has a globally asymptotically stable disease free equilibrium for a special case when the reproduction number is less than unity. And it exhibits the phenomenon of backward bifurcation, where the stable disease-free co-exists with a stable endemic equilibrium, when the associated reproduction number is less than unity. This phenomenon is caused by the re-infection of the exposed and infectious birds with low pathogenic avian influenza. The model in the absence of mutation, progression and re-infection with the highly pathogenic strain can have a continuum of co-existence equilibria when the associated reproduction number of the two strains are equal and exceed unity. On the other hand the model can exhibit co-existence or competitive exclusion between the two strains when the reproduction number of one strain exceed the other strain. (Received July 25, 2011)

1073-92-84 **Maria P McGee*** (mmcgee@wfubmc.edu), Medical Center Blvd, Surgical Sciences Division, Plastic and Reconstructive Surgery Department, Winston-Salem, NC 27101. *Describing transport processes in biological systems:An example from blood coagulation kinetics.* Preliminary report.

Biological systems are characterized by change. The equations of biological change are based on physical laws for the conservation of mass, momentum and energy and generally intent to describe concentration, velocity and temperature as a function of two independent variables, time and position. Partial differential equations are valuable to understand dynamics in bio-molecular systems when used to model conditions not directly accessible by experiment and to test hypotheses enunciated on the basis of limited experimental or clinical information. The coagulation of blood is an important biological process where differential equations have played a role in determining mechanisms and predicting outcomes. The process is initiated by macromolecular reactions assembled on surfaces and requires transfer and exchange of reactants and products between the blood and the catalytic surface. In this report, the use of reaction-diffusion equations to complement experimental and theoretical biomedical research will be illustrated by comparing predicted and measured rates of coagulation factor Xa generation on the membrane of live cells. The simplified assumptions of the mathematical model are exploited to identify variables, explain results and design new experiments. (Received July 27, 2011)

1073-92-91 **Isabel K. Darcy*** (idarcy.math@gmail.com). *DNA knot distances.*

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 July 27, 2011)

1073-92-97 **Andrew Nevai*** (anevai@math.ucf.edu), Department of Mathematics, Orlando, FL 32816, and **Robert Van Gorder** (rav59@cornell.edu), Department of Mathematics, Ithaca, NY 14853. *The influence of a resource subsidy on predator-prey interactions.*

We study the influence of a donor-controlled resource subsidy on predator-prey interactions. The prey increases logistically, the subsidy appears arithmetically, and the predator experiences satiation. In one model, the prey and subsidy are found together, and in a second they are spatially separated. Criteria for feasibility and stability of the different equilibrium states are discussed. Implications for a biological system involving arctic foxes (predator), lemmings (prey), and seal carcasses (subsidy) are considered. (Received July 28, 2011)

1073-92-111 **Andrew M. Oster*** (andrew.oster@ens.fr), Robinson Hall (Math Dept), Washington & Lee University, 204 West Washington Street, Lexington, VA 24450-2116, and **Philippe Faure** and **Boris S. Gutkin**. *Mechanisms for multiple activity modes of midbrain DA neurons.*

Midbrain dopaminergic neurons send numerous projections to cortical and sub-cortical areas, and in a manner dependent upon their activities, diffusely release dopamine (DA) to their targets. Recent experimental studies have shown that DAergic neuronal bursting is associated with a significantly greater degree of DA release than an equivalent tonic activity pattern. Past computational models for DA cell activity relied upon somatodendritic mechanisms in order to generate DA neuronal bursting. However, recent experimental studies indicate that burst firing can be generated somatically, suggesting that a single-compartmental model should be sufficient for generating the observed DA neuronal dynamics.

In this work, we introduce such a model for DA neuronal dynamics and demonstrate that this model captures the qualitative behavior of DAergic neuronal dynamics: quiescence, tonic firing and bursting. Our modeling studies suggest that a reduction of the SK conductance often primes DA neuronal bursting. Moreover, our model exhibits burst firing events elicited via stimulus driven events, manifested by rises in the amount of NMDA. This model for DA cell activity could be further modified to elucidate key differences between two classes of midbrain DA neurons: VTA or SNc. (Received July 29, 2011)

1073-92-117 **Shigui Ruan*** (ruan@math.miami.edu), Department of Mathematics, University of Miami, Coral Gables, FL 33124. *Analysis of Rabies in China: Transmission Dynamics and Control.*

Human rabies is one of the major public-health problems in China. In this article, in order to explore effective control and prevention measures we propose a deterministic model to study the transmission dynamics of rabies in China. The model consists of susceptible, exposed, infectious, and recovered subpopulations of both dogs and humans and describes the spread of rabies among dogs and from infectious dogs to humans. The model simulations agree with the human rabies data reported by the Chinese Ministry of Health. We estimate that the basic reproduction number R0 = 2 for the rabies transmission in China and predict that the number of the human rabies is decreasing but may reach another peak around 2030. We also perform some sensitivity analysis of R0 in terms of the model parameters and compare the effects of culling and immunization of dogs. Our study demonstrates that (i) reducing dog birth rate and increasing dog immunization coverage rate are the most effective methods for controlling rabies in China; and (ii) large scale culling of susceptible dogs can be replaced by immunization of them (based on joint work with J. Zhang, Z. Jin, G.-Q. Sun and T. Zhou). (Received July 29, 2011)

1073-92-125 **ilker Tunc*** (itunc@email.wm.edu), Applied Science Department, College of William & Mary, McGlothlin-Street Hall 314, Williamsburg, VA 23185, and **Leah B Shaw**. *Dynamics of infection spreading in an adaptive network with two coupled communities.*

Epidemic spreading in a population with heterogeneous contacts has frequently been modeling using social networks. However, people tend to change their social connections during an epidemic in order to avoid disease exposure, which makes the structure of the network change adaptively in response to the dynamics of the nodes. This feature has been studied before without considering community structure. Here we study the effect of community structure on epidemic spread in adaptive networks. We use an SIS (susceptible-infected-susceptible) model in an adaptive network having two coupled communities. We show the effect of coupling and adaptation on epidemic spreading in heterogeneous communities. We also show how the network structure changes in response to infection spread in the network. (Received July 29, 2011)

1073-92-127 **Paula Budu-Grajdeanu*** (pgrajdea@su.edu), 1460 University Drive, Winchester, VA 22601. *Can we personalize therapy for lupus nephritis using mathematics?*

Lupus nephritis is a chronic, relapsing-remitting autoimmune disease that damages the kidneys - immune complexes and auto-antibody accumulate within the kidneys resulting in inflammatory injury to the kidneys. Although the prognosis for lupus nephritis has dramatically improved with aggressive immunosuppressive therapies, these drugs carry significant side effects. To improve the effectiveness of these drugs, biomarkers of renal flare cycle are integrated into a mathematical model of kidney inflammation to detect the onset, severity, and responsiveness of kidney relapses, and to modify therapy accordingly. The mathematical model is calibrated to actual individual patient data sets to qualitatively reproduce the observed clinical behavior for each patient, and to better understand disease mechanisms specific to each patient. Furthermore, simulations based on patient-specific parameters suggest that effective combination of clinical data and physiologically based mathematical

modeling may provide a basis for more comprehensive modeling and improved clinical care for lupus nephritis patients. (Received July 30, 2011)

1073-92-140 **Javier Arsuaga*** (jarsuaga@sfsu.edu), 1600 Holloway Ave., San Francisco, CA 94116, and **Mariel Vazquez**, **Ken Hinson** and **Yuanan Diao**. *Understanding the formation of kinetoplast minicircle networks in trypanosomes.*

Trypanosoma parasites 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 confined 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 paper we quantify the effects of the confinement on the topology of such a minicircle network. We introduce a simple mathematical model in which a collection of randomly oriented minicircles are spread over a rectangular grid. We present analytical and computational results showing the existence of a critical percolation density, that the probability of forming a network that saturates the confining volume increases exponentially, the mean minicircle valence increases linearly with density. When these results are interpreted in the context of the mitochondrial DNA of the trypanosome they suggest that confinement plays a key role on the formation of the linked network. (Received July 31, 2011)

1073-92-148 **Marisa C Eisenberg*** (meisenberg@mbi.osu.edu), 378 Jennings Hall, 1735 Neil Ave., The Ohio State University, Columbus, OH 43210. *Exploring cholera dynamics and transmission pathways using identifiability and parameter estimation.*

Cholera is a waterborne intestinal infection which causes profuse, watery diarrhea, vomiting and dehydration. A major public health question involves understanding the modes of cholera transmission. In particular, given data for an outbreak, can we determine the role and relative importance of direct (person-to-person) vs. environmental (waterborne) routes of transmission? To examine this issue, we explored the identifiability and parameter estimation of a differential equation model of cholera dynamics. We used a computational algebra approach to establish whether it is possible to determine the transmission rates from case data (i.e. whether the transmission rates are identifiable).

Our results show that both direct and environmental transmission routes are identifiable, though they become practically unidentifiable with fast water dynamics. Adding measurements of pathogen shedding or water concentration can improve identifiability and allow more accurate estimation of waterborne transmission parameters, as well as the basic reproduction number. Parameter estimation for a recent outbreak in Angola suggests that both transmission routes are needed to explain the observed cholera dynamics. I will also discuss some ongoing applications to the current cholera outbreak in Haiti. (Received July 31, 2011)

1073-92-155 **Mary Therese Padberg*** (mtpadberg@gmail.com), **Isabel Darcy**, **Stephen Levene** and **Rob Scharein**. *Exploring the Conformation of DNA: Adding Geometry to Known Topology.*

Understanding the conformation of protein-bound DNA is extremely important for biological and medical research, including improvement of drug creation and administration methods. Many protein-bound DNA conformations have been catalogued in the Protein Data Base; however the process of cataloging larger complexes can prove extremely difficult or unsuccessful. When standard lab techniques fail to determine a conformation, we turn to a branch of mathematical knot theory, tangle analysis, used in conjunction with difference topology experiments to analyze the topology of protein-bound DNA. In this talk, we will discuss these techniques and explain why topology alone is not enough. We will introduce preliminary software which can be used to determine likely DNA geometries consistent with protein-bound DNA topologies. Combining geometric and topological solutions will allow us to more accurately describe conformations for large protein-bound DNA complexes. (Received July 31, 2011)

1073-92-179 **Karen A Yokley*** (kyokley@elon.edu), Elon University, Department of Mathematics & Statistics, 2320 Campus Box, Elon, NC 27244. *Sensitivity Investigations on a Mathematical Model for the Simulation of Epileptic Seizures.* Preliminary report.

Epileptic seizures are believed to arise in the CA3 region of the hippocampus, but the generation of these seizures is not well understood. A previous ordinary differential equation model of a subnetwork of excitatory and inhibitory pathways is slightly modified to be more consistent with previous model literature and to more fully incorporate a time delay. The modification of this model involves two key parameters: (1) the membrane capacitance of the cells and (2) the delay which represents the time it takes for surrounding cells to communicate

via the diffusion of extracellular potassium. The sensitivity of the o.d.e. model to these two parameters is investigated in order to determine their importance in the model predictions. (Received August 01, 2011)

1073-92-181 **Nicholas S. Luke*** (luke@ncat.edu), Department of Mathematics, North Carolina A&T State University, Greensboro, NC 27411, and **Michael J. Devito**, **Christopher J. Portier** and **Hisham A. El-Masri**. *Employing a Mechanistic Model for the MAPK Pathway to Examine the Impact of Cellular All or None Behavior on Overall Tissue Response.*

The mitogen activated protein kinase (MAPK) cascade is a three-tiered phosphorylation cascade that is ubiquitously expressed among eukaryotic cells. Its primary function is to propagate signals from cell surface receptors to various cytosolic and nuclear targets. Recent studies have demonstrated that the MAPK cascade exhibits an all-or-none response to graded stimulii. This study quantitatively investigates MAPK activation in Xenopus oocytes using both empirical and biologically-based mechanistic models. Empirical models can represent overall tissue MAPK activation in the oocytes. However, these models lack description of key biological processes and therefore give no insight into whether the cellular response occurs in a graded or all-or-none fashion. To examine the propogation of cellular MAPK all-or-none activation to overall tissue response, mechanistic models in conjunction with Monte Carlo simulations are employed. An adequate description of the dose response relationship of MAPK activation in Xenopus oocytes is achieved. Furthermore, applicaiton of these mechanistic models revealed that the initial receptor-ligand binding rate contributes to the cells' ability to exhibit an all-or-none MAPK activation response. (Received August 01, 2011)

1073-92-184 **Anna Mummert*** (mummerta@marshall.edu), Marshall Univeristy, Mathematics Department, One John Marshall Drive, Huntington, WV 25755, and **Howard Weiss**. *Get the News Out Loudly and Quickly: Modeling The Influence of the Media on Limiting Infectious Disease Outbreaks.* Preliminary report.

During outbreaks of serious infectious diseases many individuals closely follow media reports of the outbreak and take steps, including self-isolation, to protect themselves from infection and possibly death. Self-isolation can take many forms including restricting local and long-distance travel and using face masks. We use mathematical modeling to show that public health agencies working together with the media can significantly decrease the severity of an outbreak by providing timely and accurate accounts of the numbers of new infections and deaths. Our model also shows that although providing such information beginning as early as possible is best, even starting to provide it well into the course of an outbreak can significantly reduce the severity of the outbreak. We illustrate our results with a simulated outbreak of Ebola Hemorrhagic Fever in a small city with a population of $50,000$. For a short-term outbreak, with no demographic turnover, we perform a rigorous sensitivity analysis for the key epidemiological characteristics: the maximum number of infected individuals at one time and the attack rate. (Received August 01, 2011)

1073-92-192 **Jan Medlock*** (medlock@clemson.edu), Box 340975, Clemson, SC 29634, **Martial L. Ndeffo Mbah** (martial.ndeffo-mbah@yale.edu), 60 College Street, New Haven, CT 06520, and **Alison P. Galvani** (alison.galvani@yale.edu), 60 College Street, New Haven, CT 06520. *Optimizing influenza vaccine allocation.*

The recent 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 August 01, 2011)

1073-92-197 **Mansoor A Haider*** (m_haider@ncsu.edu), Dept. of Mathematics Box 8205, NCSU, Raleigh, NC 27695-8205. *Mixture models for cartilage tissue engineering using cell-seeded scaffolds.*

Mixture models are presented for interactions between biosynthesis of extra-cellular matrix (ECM) constituents and ECM linking in biomaterial scaffolds seeded with cartilage cells (chondrocytes). Both ODE-based (temporal) models for evolution of average apparent densities and PDE-based (spatio-temporal) models will be presented for variables including unlinked ECM, linked ECM and scaffold. Effects of parameter variations on model variables are analyzed relative to baseline cases. Of particular interest is the evolution of solid phase apparent density, which is often correlated with the compressive elastic modulus of the tissue construct. These models provide a quantitative framework for assessing and optimizing the design of engineered cell-scaffold systems and guiding strategies for articular cartilage tissue engineering. (Received August 01, 2011)

1073-92-208 **Javier Arsuaga**, **Yuanan Diao** and **Kenneth Hinson*** (kehinson@uncc.edu), 1100 S. Main Street, Kannapolis, NC 28081-5436. *The effect of angle restriction on the formation of minicircle networks.*

Kinetoplast DNA in the mitochondria of some trypanosomes is partly organized in a large network of linked minicircles. The arrangement of minicircles is not entirely random; biological or experimental conditions sometimes impose restrictions on their orientations. Continuing the work from our earlier paper, we here investigate the effects of restricting the tilting and azimuthal angles of minicircles. Using the square lattice minicircle (SLM) model we observe how network formation is affected through the criteria of critical percolation density, saturation density, and mean valence. We observe that the type and magnitude of the angle restriction can have a significant effect on topological characteristics of the network. (Received August 01, 2011)

1073-92-210 **Joseph H. Tien*** (jtien@math.ohio-state.edu). *Modeling the cholera epidemic in Haiti.* Preliminary report.

I will discuss some recent work on cholera models in the context of the ongoing epidemic in Haiti. (Received August 01, 2011)

1073-92-241 **Richard Schugart***, richard.schugart@wku.edu, **Jennifer Flegg**, j.flegg@qut.edu.au, and **D.L. Sean McElwain**, s.mcelwain@qut.edu.au. *Using mathematical modeling to assess the efficacy of oxygen for problem wounds: use of hyperbaric or topical oxygen therapies.*

We extend a previously developed mathematical model (Schugart et al., PNAS 105 2628-33) for acute wound healing to investigate the application of hyperbaric and topical oxygen therapies to treat acute, delayed, and chronic wounds. In this talk, I will present the model, a sensitivity analysis of the model, and simulation results for treating the wound with hyperbaric and topical oxygen therapies. (Received August 02, 2011)

1073-92-250 **Karen M. Bliss*** (kmbliss@ncsu.edu), **H. T. Banks**, **H. T. Tran** and **Peter Kotanko**. *Model and Simulation of Red Blood Cell Dynamics in Patients with Chronic Kidney Disease.* Preliminary report.

Kidneys are the main site of production of the hormone erythropoietin (EPO) that is the major regulator of erythropoiesis, or red blood cell production. EPO level is normally controlled by a negative feedback mechanism in the kidneys, but patients with chronic kidney disease (CKD) do not produce sufficient levels of EPO to maintain blood hemoglobin concentration.

In order to prevent anemia, patients typically receive recombinant human EPO (rHuEPO) intravenously to stimulate red blood cell production. Iron is required to produce hemoglobin, and iron deficiency can be an issue among patients receiving rHuEPO therapy, so intravenous iron supplementation is common among patients undergoing rHuEPO therapy. Iron availability is negatively affected by inflammation level in the body.

An age-structured model is developed for red blood cell dynamics in patients with CKD. Both rHuEPO therapy and iron therapy are taken into consideration, as is the overall inflammation level in the body. Simulations are performed under various conditions and treatment protocols.

This is joint work with H.T. Banks and H.T. Tran of the Center for Research in Scientific Computation at North Carolina State University, along with Peter Kotanko of Renal Research Institute in New York. (Received August 02, 2011)

1073-92-251 **Rebecca A Segal*** (rasegal@vcu.edu). *Modeling the Effects of Systemic Mediators on Wound Healing.*

Wound healing is a concern across many branches of medicine. During many medical procedures, from a planned surgery to an emergency treatment, the wound healing process is triggered. When the native biological processes are incapable of healing the wound, treatment options are limited. In order to improve patients' outcomes, there is a need to develop better methods of identity wounds that are at risk of becoming chronic and to identify more effective treatment options for these wounds. It has been shown that altering the levels of systemic hormones such as estrogen and cortisol impact healing outcomes. This ODE model is used to identify and test new treatment methodologies for healing dermal wounds in the presence of these systemic mediators. (Received August 02, 2011)

1073-92-255 **Jing Li*** (li_j@math.psu.edu), Department of Mathematics, Penn State University, University Park, 109 McAllister Building, State College, PA 16802, **Darla V. Lindberg**, Department of Architecture, Pennsylvania State University, University Park, State College, PA 16802, **Rachel A. Smith**, Department of Communication Arts & Sciences, Pennsylvania State University, University Park, State College, PA 16802, and **Timothy C. Reluga**, Department of Mathematics, Pennsylvania State University, University Park, State College, PA 16802. *Intervene or Not? The Theory of Health Commons Management for Infectious Diseases.*

Government investment in public health policies can elicit strong responses from individuals. These responses can promote, reduce and even reverse the expected benefits of the policies. Therefore, projections of individual responses to policy can be important ingredients into policy design. Yet our foresight of individual responses to public health investment remains limited. This paper formulates a population game to explore how individual and government investments impact the health commons. We model the problem of infectious disease management through reductions in transmission risk for a disease that does not elicit immunity. We identify three common relationships between government and individual investments and determine how each relationship alters policy responses and health outcomes. We also provide general bounds on the magnitude of practical investment by individuals. The methods we present can be extended to address specific policy problems where public responses are expected to impose key feedbacks. (Received August 02, 2011)

1073-92-259 **Xiaoming Zheng*** (zheng1x@cmich.edu), PE 214, Mathematics, Central Michigan University, Mount Pleasant, MI 48858, and **Yeonhyang Kim**, **Leela Rakesh** and **En-Bing Lin**. *A multiscale model of reaction and diffusion in angiogenesis and a conservative multiresolution finite volume method.*

We propose a multiscale model to combine reactions on thin blood vessel capillaries and diffusion in bulk tissue domain in angiogenesis, and a conservative multiresolution finite volume scheme. In angiogenesis, we study chemicals such as growth factors that have two processes occurring at different spatial scales simultaneously: ligand/receptor binding kinetics on thin capillaries, and the tissue-level diffusion in the three-dimensional tissue domain. We first derive a new multiscale model where a line Dirac delta function is introduced to integrate these two processes, and we compare this new model with existing models. Then we develop a conservative finite volume method to solve the reaction and diffusion processes where we use a finer mesh on capillary centerlines than the mesh in the tissue domain to accurately capture faster and larger data changes along capillaries. In addition to the multiresolution meshes, another challenge is the constantly-changing capillary shape and length. To overcome these difficulties, we construct a data transferring algorithm between reaction and diffusion meshes, which is proved to conserve the mass between two meshes and retain the variation in the reaction domain. (Received August 03, 2011)

1073-92-260 **Helen J. Wearing*** (hwearing@unm.edu). *Deconstructing dengue dynamics: modeling a multi-strain disease.*

The dengue virus is one of the most important mosquito-borne pathogens that infects humans. In regions where all four dengue serotypes co-circulate, human incidence data exhibit seasonal cycles of varying amplitude in which the dominant serotype may change from one epidemic to the next. The precise mechanisms underlying these temporal patterns have been the subject of much debate. To understand how alternative hypotheses concerning dengue infection and transmission may explain observed multi-annual cycles in disease incidence, we developed a differential equation model that incorporates both ecological and immunological mechanisms. We demonstrate that, contrary to perceived wisdom, dynamics generated solely by antibody-dependent enhancement are not consistent with serotype-specific notification data in important ways. To generate epidemics with the characteristic signatures observed in data, we find that a combination of seasonal variation in vector demography and, crucially, a short-lived period of cross-immunity is sufficient. We also show how understanding the persistence and eradication of dengue serotypes critically depends on the alternative assumed mechanisms. (Received August 03, 2011)

1073-92-261 **Howard Weiss*** (weiss@math.gatech.edu), School of Mathematics, 108E Skiles Building, 686 Cherry St, Atlanta, GA 30334, and **Anna Mummert** and **Henry Wan**. *An inverse problem for SIR transmission models and an application to the second wave of the 2009 influenza pandemic.* Preliminary report.

We consider SIR transmission models with time-dependent transmission rate. We prove that given virtually any smooth infection profile, there exist a transmission rate such that the output I(t) of the model coincides with the infection profile. We then show how this theorem provides an explicit method to estimate the transmission

rate from a time series. Finally we apply this method to estimate the transmission rate of influenza during the 2009 pandemic. In the US. We note that our recovered transmission rate seems inconsistent with the commonly presumed mechanism responsible for the second wave of the pandemic. (Received August 03, 2011)

00 ► General

1074-00-7 **Ludwig Kohaupt*** (kohaupt@beuth-hochschule.de), Department of Mathematics, Luxemburger Str. 10, D-13353, Berlin, Germany. *Optimal Bounds for dynamical technical systems of the form ẋ=A(t)x+h(t,x)+g(t),x(t0)=x0 -Basic ideas and open questions -.*

The talk deals, in concise form, with the results of 10 publications leading to the habilitation in Mathematics at the TU Freiberg/Saxonia/Germany in the year 2009. The main points are: (M1)the development of a differential calculus for norms of vector and matrix functions, (M2)the derivation of new upper and lower bounds on the solution vector and the fundamental matrix of ordinary differential equations representing linear and nonlinear, free and excited dynamical systems with vibration behavior, and (M3)the application of the differential calculus of norms from (M1) to the computation of optimal constants in known upper bounds as well as in the new upper and lower bounds from (M2). In this, •instead of giving the complete derivations, the basic ideas are sketched,and •some open questions are addressed. (Received April 13, 2011)

1074-00-14 **Evgenia Karmanova*** (janekao@mail.ru), Rabochaya 29-224, Saratov, 410028, Russia. *On congruence relations of graphs.*

A congruence of a path is an equivalence relation on the set of path's vertices all of whose classes are independent subsets. It is shown that each connected graph is a quotient-graph of a suitable path. For a tree and a star a path was found with the minimal possible number of edges, whose quotient graph is the corresponding tree or star. (Received Received June 2, 2011)

1074-00-110 **Oktay Olmez***, 240 Raphael Ave., Apt: 22, Ames, IA 50014. *Constructions of Vertex Transitive Directed Strongly Regular Graphs.*

The concept of directed strongly regular graphs was introduced in 1988 by A. M. Duval as a generalization of the concept of strongly regular graphs and doubly regular tournaments. A loopless directed graph D with v vertices is called *directed strongly regular graph* with parameters (v, k, t, λ, μ) if and only if D satisfies the following conditions:

i) Every vertex has in-degree and out-degree k.

ii) Every vertex x has t out-neighbors, all of which are also in-neighbors of x.

iii) The number of directed paths of length two from a vertex x to another vertex y is λ if there is an (directed) edge from x to y, and is μ if there is no edge from x to y.

In this talk, we will investigate two infinite families of vertex transitive directed strongly regular graphs obtained from tactical configurations. We will discuss the calculation of their automorphism groups and the relationships between the association scheme obtained from the permutation group action. (Received August 15, 2011)

1074-00-131 **Siavash H Sohrab*** (s-sohrab@northwestern.edu), Nothwestern University, Dept. Mech. Engin., 2145 Sheridan Road, Evanston, IL 60208. *Scale Invariant Kinetic Theory of Ideal Gas, Riemann Hypothesis,and Trisection Problem.*

A scale invariant model of statistical mechanics is applied to derive invariant *Maxwell-Boltzmann* speed and *Planck* energy spectra of equilibrium statistical fields. The latter leads to definitions of (electron, photon, neutrino) respectively as the most-probable sizes of (photon, neutrino, tachyon) clusters stabilized by *Poincaré* (1900) stress as potential in invariant *Schrödinger* equation. Invariant form of the first law of thermodynamics is derived, and hierarchies of absolute zero temperatures and vacua are described. A modified definition of mechanical equivalent of heat is identified as the universal gas constant or *De Pretto* number 8338 that occurs in *De Pretto's* (1904) mass-energy equivalence equation

$$E = mc^2 \text{ Joules} = \frac{mc^2}{8338}\text{kcal}$$

The coincidence of normalized spacings between zeros of Riemann zeta function and the normalized *Maxwell-Boltzmann* distribution and its connections to *Riemann Hypothesis* and noncommutative geometry of *Connes* (1998) are described. Also, a solution of trisection problem is presented. It is argued that since *Wantzel's* (1837) theory involves rational numbers it does not apply to the trisection problem because trisecting angles involves

π and hence transcendental numbers that are not roots of polynomials with constant coefficient. (Received August 17, 2011)

1074-00-258 **Qiang Du** (qdu@math.psu.edu), McAllister Building, Penn State University, STATE COLLEGE, PA 16802, and **Kun Zhou*** (zhou@math.psu.edu), McAllister Building, Penn State University, State College, PA 16802. *Numerical Simulation of Nonlinear Peridynamic models.* Preliminary report.

In the work, we investigate the energy landscape of the nonlinear peridynamic models and the behavior of the models near or at the cracks by numerical experiments. The capability of the Peridynamic models on the crack/fracture simulation is further illustrated. (Received August 22, 2011)

1074-00-329 **Patrick D McMullen*** (p-mcmullen@northwestern.edu), 2145 Sheridan Road Room E136, Evanston, IL 60208, and **Erin Z Aprison**, **Peter B Winter**, **Luis AN Amaral**, **Richard I Morimoto** and **Ilya Ruvinsky**. *Macro-level modeling of the response of* C. elegans *reproduction to chronic heat stress.* Preliminary report.

A major goal of systems biology is to understand how organism-level behavior arises from a myriad of molecular interactions. Often this involves complex sets of rules describing interactions among a large number of components. As an alternative, we have developed a simple, macro-level model to describe how chronic temperature stress affects reproduction in *C. elegans*. Our approach uses fundamental engineering principles, together with a limited set of experimentally derived facts, and provides quantitatively accurate predictions of performance under a range of physiologically relevant conditions. We generated detailed time-resolved experimental data to evaluate the ability of our model to describe the dynamics of *C. elegans* reproduction. We find considerable heterogeneity in responses of individual animals to heat stress, which can be understood as modulation of a few processes and may represent a strategy for coping with the ever-changing environment. While the molecular details underlying most biological processes are numerous and complex, our results show that a minimal model of a process can be sufficient for capturing system dynamics. (Received August 23, 2011)

1074-00-336 **Adonus L. Madison**, Department of Mathematics, Lane College, Jackson, TN 38301, and **Junhua Wu***, Department of Mathematics, Lane College, Jackson, TN 38301. *On codes from finite projective plane.*

Let $\mathcal{O}$ be a conic in the classical projective plane PG(2,q), where q is an odd prime power. With respect to $\mathcal{O}$, the lines of PG(2,q) are classified as passant, tangent, and secant lines, and the points of PG(2,q) are classified as internal, absolute and external points. The incidence matrices between the secant/passant lines and the external/internal points were used to produce several classes of structured low-density parity-check binary codes. In particular, the dimension formula for the binary code $\mathcal{L}$ which arises as the $\mathbb{F}_2$-null space of the incidence matrix between the passant lines and the internal points to $\mathcal{O}$ has been conjectured. In this talk, we first explore geometric structures related to $\mathcal{L}$ as well as some applications of $\mathcal{L}$, and then we prove the conjecture on the dimension of $\mathcal{L}$ by using a combination of techniques from finite geometry and representation theory. (Received August 29, 2011)

05 ► Combinatorics

1074-05-15 **Anastasiya Vlasova*** (VAnastasiyaV@gmail.com), Saratov region, Saratov district, Sokolovyy, 22-69, 410501, Russia. *Attractors of dynamic systems associated with paths and cycles.*

The author considers the known problem whether a given state of a dynamic system is periodic or not. We prove a theorem about attractors of dynamic systems associated with paths, and a theorem that characterizes states belonging to attractors and so describes attractors of dynamic systems associated with cycles. (Received June 2, 2011)

1074-05-16 **Lon H Mitchell*** (lonmitchell@gmail.com) and **Shaun M Fallat**. *Colin de Verdière Parameters of Chordal Graphs.*

Two important graph parameters, developed by Colin de Verdière, are connected with the maximum nullity of certain real symmetric matrices associated with a given graph. In this talk, we calculate these parameters μ and ν for chordal graphs. (Received June 7, 2011)

1074-05-17 **Bangteng Xu*** (bangteng.xu@eku.edu), Department of Mathematics and Statistics, Eastern Kentucky University, 521 Lancaster Avenue, Richmond, KY 40475. *On Wreath Products of C-algebras, Table Algebras, and Association Schemes.*

In this talk we will first present characterizations of wreath products of C-algebras, and show that the dual of the wreath product of C-algebras is isomorphic to the wreath product of the duals of those C-algebras in the reverse order. Then we talk about the Krull-Schmidt type theorems for the wreath products of table algebras as well as for the wreath products of association schemes. We will also present the properties of the irreducible characters of wreath products of table algebras, and discuss some applications to the wreath product of one-class association schemes. (Received June 09, 2011)

1074-05-36 **Yoshiharu Kohayakawa**, **Sangjune Lee*** (slee242@emory.edu) and **Vojtech Rodl**. *The maximum size of a Sidon set contained in a sparse random set of integers.*

A set A of integers is a *Sidon set* if all the sums $a_1 + a_2$, with $a_1 \leq a_2$ and $a_1, a_2 \in A$, are distinct. In the 1940s, Chowla, Erdős and Turán showed that the maximum possible size of a Sidon set contained in $[n] = \{0, 1, \ldots, n-1\}$ is $\sqrt{n}(1 + o(1))$. We study Sidon sets contained in sparse random sets of integers, replacing the 'dense environment' $[n]$ by a sparse, random subset R of $[n]$.

Let $R = [n]_m$ be a uniformly chosen, random m-element subset of $[n]$. Let $F([n]_m) = \max\{|S|\colon S \subset [n]_m \text{ Sidon}\}$. An abridged version of our results states as follows. Fix a constant $0 \leq a \leq 1$ and suppose $m = m(n) = (1 + o(1))n^a$. Then there is a constant $b = b(a)$ for which $F([n]_m) = n^{b+o(1)}$ almost surely. The function $b = b(a)$ is a continuous, piecewise linear function of a, not differentiable at two points: $a = 1/3$ and $a = 2/3$; between those two points, the function $b = b(a)$ is constant. This is joint work with Yoshiharu Kohayakawa and Vojtech Rödl. (Received July 18, 2011)

1074-05-44 **Anant Godbole*** (godbolea@etsu.edu), **Jessie Deering**, **William Jamieson** and **Lucia Petito**. *Hitting random set systems.* Preliminary report.

A set $A \subseteq [n] := \{1, 2, \ldots, n\}$ is said to *hit* a collection $\mathcal{B}$ of subsets of $[n]$ if $|B \cap A| \geq 1$ for each $B \in \mathcal{B}$. The term *transversal* is sometimes used in place of "hitting set." We select subsets of $[n]$ at random with each set chosen independently with probability $p = p_n$ and exhibit a highly sharp threshold for the minimal size of a hitting set. (Received July 29, 2011)

1074-05-51 **Luz M. DeAlba*** (luz.dealba@drake.edu), Mathematics and Computer Science, Drake University, 2507 University Avenue, Des Moines, IA 50311. *Minimum Skew rank of some outerplanar graphs.*

The minimum skew rank of a simple graph G over a field $\mathbb{F}$ is the smallest possible rank among all skew-symmetric matrices, over $\mathbb{F}$, whose (i, j)-entry (for $i \neq j$) is nonzero whenever $\{i, j\}$ is an edge in G and is zero otherwise. In the presentation we give an algorithm for computing the minimum skew rank of cactus graphs. We introduce a family of 2-connected outerplanar graphs for which the minimum skew rank equals the maximum skew rank, and also serves as a counterexample to a conjecture posed in the IMA Group article: Minimum rank of skew-symmetric matrices described by a graph, *Linear Algebra and its Applications* 432 (2010) 2457-2472. Finally we compute the minimum skew rank of some special 2-connected outerplanar graphs. (Received August 03, 2011)

1074-05-52 **James A. Davis*** (jdavis@richmond.edu), Department of Mathematics and Comuter Science, University of Richmo, VA 23233. *Difference Sets and Association Schemes.* Preliminary report.

Difference Sets have been used to construct Association Schemes in a variety of settings. We outline several of these constructions and look for general themes. The primary goal of this talk is to see if we can identify other settings where Difference Set techniques can be used to construct interesting Association Schemes. (Received August 03, 2011)

1074-05-53 **Richard A. Brualdi*** (brualdi@math.wisc.edu), 607 Van Vleck, UW-Madison, Madison, WI 53706. *Matrix classes: old and new.* Preliminary report.

Classes of (0,1) and, more generally, nonnegative integral matrices are basic to combinatorics and graph theory and have a long history. Early investigations were largely concerned with the structure of such classes and the extreme values of various combinatorial parameters. Some new classes (generalizing the Gale-Ryser classes in an unexpected way) and a new parameter (motivated by the study of combinatorial batch codes) have been recently introduced. We shall give an exposition of these old and recent developments. (Received August 03, 2011)

1074-05-60 **Tim Penttila*** (penttila@math.colostate.edu), 101 Weber Building, Fort Collins, CO 80523-1874. *Projective planes in which every quadrangle lies on a unique Baer subplane.*

In 1956, A.M. Gleason showed that every finite projective plane in which every quadrangle lies on a Fano subplane is Desarguesian (of even order). In 2000, A. Blokhuis and P. Sziklai showed the similar result that every projective plane of order the square of a prime in which every quadrangle lies on a unique Baer subplane is Desarguesian. Here, we generalize their result, by showing that every finite projective plane in which every quadrangle lies on a unique Baer subplane is Desarguesian (of square order). (Received August 07, 2011)

1074-05-62 **David Galvin*** (dgalvin1@nd.edu), University of Notre Dame, South Bend, IN. *Counting graph homomorphisms.*

A *homomorphism* from graph G to H is an adjacency-preserving map between vertex sets. Homomorphisms can be used to encode numerous graph theory notions, such as independent sets and proper colourings, as well as providing a language in which to discuss statistical physics hard-constraint spin models.

In this talk we address an extremal question for graph homomorphisms: given H, which graph in the class of n-vertex, d-regular graphs admits the most homomorphisms to H? With Tetali, we answered this question for *bipartite* graphs (the answer is the same for each H: a disjoint union of $n/2d$ copies of the complete d-regular bipartite graph). Zhao showed that for many H, including the H that encodes independent sets, this remains the answer for not-necessarily-bipartite graphs. In general, however, the answer turns out to depend on H.

We present a hopeful conjecture, and survey all that we know. (Received August 07, 2011)

1074-05-67 **Mustafa Atici*** (mustafa.atici@wku.edu), Department of Mathematics and Computer Sci., Western Kentucky University, 1906 College Heights Blvd., Bowling Green, KY 42101, and **Claus Ernst**, Department of Mathematics and Computer Sci., Western Kentucky University, 1906 College Heights Blvd., Bowling Green, KY 42101. *On the range of possible integrities of graphs G(n,k).*

We discuss the range of values for the integrity of a graphs $G(n,k)$ where $G(n,k)$ denotes a simple graph with n vertices and k edges. Let $I_{max}(n,k)$ and $I_{min}(n,k)$ be the maximal and minimal value for the integrity of all possible $G(n,k)$ graphs and let the difference be $D(n,k) = I_{max}(n,k) - I_{min}(n,k)$. In this paper we give some exact values and several lower bounds of $D(n,k)$ for various values of n and k. For some special values of n and for $s < n^{1/4}$ we construct examples of graphs $G_n = G_n(n, n+s)$ with a maximal integrity of $I(G_n) = I(C_n) + s$ where C_n is the cycle with n vertices. We show that for $k = n^2/6$ the value of $D(n, n^2/6)$ is at least $\frac{\sqrt{6}-1}{3}n$ for large n. (Received August 08, 2011)

1074-05-101 **Paul M Terwilliger*** (terwilli@math.wisc.edu), Math Department, University of Wisconsin, 480 Lincoln Drive, Madison, WI 53706. *The universal Askey-Wilson algebra.*

Let $\mathbb{F}$ denote a field, and fix a nonzero $q \in \mathbb{F}$ such that $q^4 \neq 1$. We define an associative $\mathbb{F}$-algebra $\Delta = \Delta_q$ by generators and relations in the following way. The generators are A, B, C. The relations assert that each of

$$A + \frac{qBC - q^{-1}CB}{q^2 - q^{-2}}, \quad B + \frac{qCA - q^{-1}AC}{q^2 - q^{-2}}, \quad C + \frac{qAB - q^{-1}BA}{q^2 - q^{-2}}$$

is central in Δ. We call Δ the *universal Askey-Wilson algebra*. We discuss how Δ is related to the original Askey-Wilson algebra AW(3) introduced by A. Zhedanov. We discuss how Δ is related to Leonard pairs, Leonard triples, and Q-polynomial distance-regular graphs. (Received August 13, 2011)

1074-05-137 **Reshmi Nair*** (rnair@uwyo.edu), 1000 E. University Ave., Laramie, WY 82071, and **Bryan Shader**. *Acyclic matrices with few distinct and few multiple eigenvalues.*

In Combinatorial matrix theory the study of structured matrices has been of interest. In particular, the spectral properties of $S(T)$, the set of all n by n symmetric matrices corresponding to a tree T on n vertices where $a_{ij} \neq 0$ for $i \neq j$ if and only if i–j is an edge in T has been studied. We study the problem of characterizing the matrices whose nonzero entries are described by a tree T, called acyclic matrices. A new technique based on Smith Normal Form and Hamming distance will be introduced. This technique will be used to characterize the acyclic matrices, that have at most 5 distinct eigenvalues. Some results for acyclic matrices with larger diameter will be given. Also, we will discuss the problem of characterizing acyclic matrices that have at most 2 multiple eigenvalues and whose sum of multiplicities is the maximum possible. (Received August 18, 2011)

1074-05-138 **Ibrahim Abdou Saleh*** (iasaleh@math.ksu.edu), 2128 Prairie Glen Place, Manhattan, KS 66502. *A non commutative cluster structure on some hyperbolic algebras.* Preliminary report.

In this talk, I will introduce a non-commutative cluster structure that is related naturally to some Hyperbolic algebras like Weyl Algebras, classical and quantized universal enveloping algebras of the Lie algebra sl_2 and the

quantum coordinate algebra of SL(2). Some properties of this structure will be presented. The cluster structure gives rise to some combinatorial data, called cluster strings, which are used to introduce a class of representations of Weyl algebras. Irreducible and indecomposable representations are also introduced from the cluster strings. (Received August 18, 2011)

1074-05-144 **Brian W Curtin*** (bcurtin@usf.edu), University of South Florida, Department of Mathematics and Statistics, 4202 E. Fowler Ave., PHY114, Tampa, FL 33620. *Terwilliger algebras of Bol loops.*

We discuss Terwilliger algebras constructed from finite Bol loops. Bol loops are a special type of quasigroup, and Cayley tables of finite quasigroups are Latin squares. There is a well-known construction of a 4-class association scheme from a Latin square, and from any association scheme one may construct Terwilliger (subconstituent) algebras. We describe the Terwilliger algebras arising from Bol loops in this manner. (Received August 18, 2011)

1074-05-153 **Jason Ekstrand** and **Craig Erickson*** (craig@iastate.edu), 396 Carver Hall, Iowa State University, Ames, IA 50011, and **Diana Hay**, **Leslie Hogben** and **Jolie Roat**. *Positive semidefinite maximum nullity is equal to positive semidefinite zero forcing number for partial 2-trees.*

The maximum positive semidefinite nullity of a multigraph G is the largest possible nullity over all real positive semidefinite matrices whose ijth entry (for $i \neq j$) is nonzero whenever $\{i, j\}$ is a single edge in G and is zero if i and j are not adjacent. The definition of the positive semidefinite zero forcing number for simple graphs is extended to multigraphs; as for simple graphs, this parameter bounds the maximum nullity from above. The tree cover number $\mathrm{T}(G)$ is the minimum number of vertex disjoint induced simple trees that cover all of the vertices of G. The result in (Barioli, Fallat, Mitchell, and Narayan, ELA, 2011) that $\mathrm{M}_+(G) = \mathrm{T}(G)$ for an outerplanar multigraph G is extended to show that $\mathrm{Z}_+(G) = \mathrm{M}_+(G) = \mathrm{T}(G)$ for a multigraph G of tree-width at most 2. (Received August 19, 2011)

1074-05-155 **Jennifer Diemunsch**, **Michael Ferrara**, **Casey Moffatt**, **Florian Pfender** and **Paul S Wenger*** (paul.wenger@ucdenver.edu). *$\delta(G)$-Size Rainbow Matchings in Properly Edge-Colored Graphs.*

A rainbow matching in an edge-colored graph is a matching in which all the edges have distinct colors. Ryser's conjecture that odd-order Latin squares have transversals can be equivalently stated as every proper edge-coloring of $K_{n,n}$ when n is odd has a rainbow matching of size n. Motivated by Ryser's conjecture, Wang asked if there is a function $f(\delta)$ such that a properly edge-colored graph G with minimum degree δ and order at least $f(\delta)$ must have a rainbow matching of size δ. We answer this question in the affirmative; $f(\delta) = 6.5\delta$ suffices. Furthermore, the proof provides a $O(\delta(G)|V(G)|^2)$-time algorithm that generates such a matching. (Received August 19, 2011)

1074-05-156 **Michael Ferrara*** (michael.ferrara@ucdenver.edu), **TImothy Morris** and **Paul Wenger**. *Pancyclicity of 4-Connected, Claw-Free, P_{10}-Free Graphs.*

In 1984, Matthews and Sumner conjectured that every 4-connected claw-free graph is hamiltonian. This conjecture remains one of the foremost open problems on hamiltonian graphs and has spurred a great deal of additional interest in the cycle-structural properties of highly connected claw-free graphs.

A graph G is said to be *pancyclic* if G contains cycles of all lengths from 3 to $|V(G)|$. We show that if G is 4-connected, claw-free, and P_{10}-free, then G is either pancyclic or it is the line graph of the Petersen graph. This implies that every 4-connected, claw-free P_9-free graph is pancyclic, which is best possible and extends a result of Gould, Łuczak, and Pfender [R. Gould, T. Łuczak, and F. Pfender, Pancyclicity in 3-connected graphs: Pairs of forbidden subgraphs, *J. Graph Theory* **47** (2004), 183-202]. If time permits, we will also discuss some additional results on the pancyclicity of 4-connected claw-free graphs without a generalized net. (Received August 19, 2011)

1074-05-159 **Michael Young*** (myoung@iastate.edu) and **Lale Ozkahya**. *Anti-Ramsey number of matchings in hypergraphs.*

A k-matching in a hypergraph is a set of k edges such that no two of these edges intersect. The anti-Ramsey number of a k-matching in a complete s-uniform hypergraph, $\mathcal{H}$, on n vertices, $ar(n, s, k)$, is the smallest integer c, such that in any coloring of the edges of $\mathcal{H}$ with exactly c colors, $\mathcal{H}$ will contain a k-matching such that each edge of the matching has a distinct color. The Turán number, $ex(n, s, k)$, is the maximum number of edges in an s-uniform hypergraph on n vertices with no k-matching. It is known that for $n > 2k$,

$ar(n,2,k) = ex(n,2,k-1)+2$ and for $n = 2k$, $ar(n,2,k) = \begin{cases} ex(n,2,k-1)+2 & \text{if } k<7 \\ ex(n,2,k-1)+3 & \text{if } k \geq 7. \end{cases}$ We conjecture, for $k \geq 2$, if $n > sk$, $ar(n,s,k) = ex(n,s,k-1)+2$ and if $n = sk$, $ar(n,s,k) = \begin{cases} ex(n,s,k-1)+2 & \text{if } k < c_s \\ ex(n,s,k-1)+s+1 & \text{if } k \geq c_s \end{cases}$,where c_s is a constant dependent on s. We prove this conjecture for $k = 2, k = 3$, and sufficiently large n, as well as provide upper and lower bounds. (Received August 19, 2011)

1074-05-175 **Ryan R. Martin*** (rymartin@iastate.edu), 396 Carver Hall, Department of Mathematics, Iowa State University, Ames, IA 50011, and **Tracy McKay** (tmckay16@iastate.edu), 396 Carver Hall, Department of Mathematics, Iowa State University, Ames, IA 50010. *On the edit distance for $K_{2,t}$-free graphs.*

The edit distance between two graphs on the same vertex set is defined to be the size of the symmetric difference of their edge sets. The edit distance function of a hereditary property, $\mathcal{H}$, is a function of p and measures, asymptotically, the furthest graph of edge density p from $\mathcal{H}$ under this metric. In this talk, we address the hereditary property Forb$(K_{2,t})$, the property of having no induced copy of the complete bipartite graph with 2 vertices in one class and t in the other. Employing an assortment of techniques and colored regularity graph constructions, we are able to determine the edit distance function over the entire domain $p \in [0,1]$ when $t = 3, 4$ and extend the interval over which the edit distance function for Forb$(K_{2,t})$ is known for all values of t, determining its maximum value for all odd t. We also prove that the function for odd t has a nontrivial interval on which it achieves its maximum. These are the only known principal hereditary properties for which this occurs.

In the process of studying this class of functions, we encounter some surprising connections to extremal graph theory problems, such as strongly regular graphs and the problem of Zarankiewicz. (Received August 19, 2011)

1074-05-178 **Ron Solomn** and **Andrew Woldar*** (andrew.woldar@villanova,edu), Villanoba University, Department of Mathematics and Statisitcs, Villanova, PA 19085. *All simple groups are characterized by their non-commuting graphs.* Preliminary report.

For G a group, we define its non-commuting graph $\nabla(G)$ as follows: The vertex set of $\nabla(G)$ consists of all elements of G that are not in $Z(G)$, and two vertices x, y are adjacent provided they do not commute in G.

It is most natural to seek conditions under which G can be reconstructed from $\nabla(G)$. (Some conditions are surely necessary, as is evidenced by the miniscule example $\nabla(D_8) \cong \nabla(Q_8)$.) A conjecture of Abdollahi, Akbari and Maimani proposes that the property of being a nonabelian simple group is sufficient.

Recently, this conjecture was resolved in the affirmative by Ron Solomon and the speaker. In my talk I will discuss the architecture of the proof, highlighting some of the core ideas. (Received August 20, 2011)

1074-05-183 **Jonathan Cutler*** (jonathan.cutler@montclair.edu), Department of Mathematical Sciences, Montclair State University, One Normal Avenue, Montclair, NJ 07043, and **James Alexander** and **Tim Mink**. *Independent sets in graphs with given minimum degree.*

The enumeration of independent sets in graphs has been the topic of much recent research. Kahn gave an upper bound on the number of independent sets in regular bipartite graphs, and Zhao extended this result to general regular graphs. Galvin recently introduced the study of independent sets in graphs with given minimum degree and, in this talk, we will present some results related to this topic. (Received August 20, 2011)

1074-05-191 **Jae-Ho Lee*** (jhlee@math.wisc.edu), Dep. of Mathematics, UW-Madison, 480 Lincoln Dr. Van Vleck, Madison, WI 53706-1388. *T-modules for Q-polynomial distance-regular graphs with a Delsarte clique.*

Let Γ denote a Q-polynomial distance-regular graph with a Delsarte clique C. We fix an x in C. Using x and C we construct a two-dimensional distance partition, and it turns out this partition is equitable. This partition naturally gives a vector space W that is a module for both the Terwilliger algebra $T(x)$ and the Terwilliger algebra $T(C)$. In this talk, we give a detailed description of the space W. (Received August 22, 2011)

1074-05-194 **Suil O** and **Douglas B. West*** (west@math.uiuc.edu). *The Chinese Postman Problem in regular graphs of odd degree.*

The Chinese Postman Problem in a graph is the problem of finding a shortest closed walk traversing all the edges. In a $(2r+1)$-regular graph, the problem is equivalent to finding a smallest spanning subgraph in which all vertices have odd degree. For a 3-regular graph with n vertices, we prove that there is always such a subgraph with at most $(2n-5)/3$ edges, and this is sharp. We characterize the graphs where equality holds. The family extends to a construction for general r, which we conjecture is also optimal. (Received August 21, 2011)

1074-05-214 **John B Polhill*** (jpolhill@bloomu.edu), Department of Mathematics, CS, and Stats, Bloomsburg University, 400 East Second Street, Bloomsburg, PA 17815. *On Relationships Between Association Schemes and Partial Difference Sets.* Preliminary report.

There have been numerous recent results regarding partial difference sets (PDSs), which are algebraic structures that have Cayley graphs that are strongly regular. Partial difference sets have rich properties that seem well suited for solving certain problems in association schemes. Certainly PDSs can be viewed as symmetric association schemes with two classes. But recent results seem to indicate that PDSs have many more interesting connections with association schemes. We will discuss some of these results, and very much hope to invite discussion on how further connections may be made. (Received August 22, 2011)

1074-05-217 **Caroline J Klivans** (cjk@math.uchicago.edu), **Art M Duval** (artduval@math.utep.edu) and **Jeremy L Martin*** (jmartin@math.ku.edu), 405 Snow Hall, 1460 Jayhawk Boulevard, Lawrence, KS 66045. *Spanning trees of shifted simplicial complexes.*

Shifted simplicial complexes are higher-dimensional generalizations of threshold graphs. They are known or conjectured to be extremal with respect to many combinatorial invariants, including face numbers, homology, degree sequence, and Laplacian eigenvalues. Duval and Reiner proved that shifted simplicial complexes have integer Laplacian spectra. We present a weighted generalization of the Duval-Reiner theorem and its consequences for enumeration of simplicial spanning trees. (Received August 22, 2011)

1074-05-227 **Andrew Beveridge*** (abeverid@macalester.edu), Department of Mathematics, Macalester College, 1600 Grand Avenue, Saint Paul, MN 55105, and **Andrzej Dudek**, **Alan Frieze** and **Tobias Mueller**. *Cops and Robbers on Geometric Graphs.*

In the game of cops and robbers, one robber is pursued by a set of cops on a graph G. In each round, these agents move between vertices along the edges of the graph. The cop number $c(G)$ denotes the minimum number of cops required to catch the robber in finite time. We study the cop number of geometric graphs. For points $x_1, \ldots, x_n \in R^2$, and $r \in R^+$, the vertex set of the geometric graph $G(x_1, \ldots, x_n; r)$ is the graph on these n points, with x_i, x_j adjacent when $\|x_i - x_j\| \leq r$. We prove that $c(G) \leq 9$ for any connected geometric graph G in R^2. We improve on this bound for random geometric graphs that are sufficiently dense. Let $G(n, r)$ denote the probability space of geometric graphs with n vertices chosen uniformly and independently from $[0, 1]^2$. For $G \in G(n, r)$, we show that with high probability (whp), if $nr^4 \gg \log n$, then $c(G) \leq 2$, and if $nr^5 \gg \log n$, then $c(G) = 1$ Finally, we provide a lower bound near the connectivity regime of $G(n, r)$: if $nr^2 \ll \log^2 n$ then $c(G) > 1$ whp. (Received August 22, 2011)

1074-05-229 **Eric M. Nelson*** (nelson@math.colostate.edu), Colorado State University, 101 Weber Building, Fort Collins, CO 80523-1874. *Connections with BLT-sets.* Preliminary report.

As BLT-sets arose from derivation of flocks their connections are just as plentiful. Through flocks, they are related to projective planes (via Thas-Walker and hyperbolic vibrations), generalized quadrangles, fibrations, as well as most recently, hemisystems and cometric 4-class association schemes. These connections will be briefly surveyed.

Due to a theorem of Thas and Payne, if the group of a BLT-set is known, the group of all other related objects are also known. Along these lines, there is only one remaining infinite family of BLT-sets with group as yet unknown. A result will be given that is a step towards computing the group of this last infinite family: the Mondello BLT-sets. (Received August 22, 2011)

1074-05-255 **J Balogh** and **J Butterfield*** (jbutter2@illinois.edu), Department of Mathematics, 1409 W. Green St, Urbana, IL 61801, and **P Hu**, **J Lenz** and **D Mubayi**. *On the Chromatic Thresholds of Hypergraphs.*

Let F be a family of r-uniform hypergraphs. The chromatic threshold of F is the infimum of all non-negative real numbers c such that the subfamily of F comprising hypergraphs H with minimum degree at least $c\binom{|V(H)|}{r-1}$ has bounded chromatic number. This parameter has a long history for graphs ($r = 2$), and we begin its systematic study for hypergraphs.

Łuczak and Thomassé recently proved that the chromatic threshold of near bipartite graphs is zero, and our main contribution is to generalize this result to r-uniform hypergraphs. In an attempt to generalize Thomassen's result that the chromatic threshold of triangle-free graphs is 1/3, we prove bounds for the chromatic threshold of the family of 3-uniform hypergraphs not containing $\{abc; abd; cde\}$, the so-called generalized triangle.

In order to prove upper bounds we introduce the concept of fiber bundle dimension, based on the idea of Vapnik-Chervonenkis dimension in hypergraphs. Our lower bounds follow from explicit constructions, many of which use a generalized Kneser hypergraph. Using methods from extremal set theory, we prove that these

generalized Kneser hypergraphs have unbounded chromatic number. This generalizes a result of Szemerédi for graphs. (Received August 22, 2011)

1074-05-256 **Michael D. Barrus*** (michael.barrus@bhsu.edu), 1200 University Street Unit #9110, Spearfish, SD 57783. *Residues and independence numbers of unigraphs.*

The residue $r(G)$ of a graph G is the number of zeros left after fully reducing the degree sequence of G via the Havel-Hakimi algorithm. The residue is one of the best known lower bounds on the independence number of a graph in terms of the degree sequence. Though this bound may be arbitrarily weak for graphs in general, we show that if G is the unique realization of its degree sequence, then the independence number of G is either $r(G)$ or $r(G) + 1$, and we determine which value it is. (Received August 22, 2011)

1074-05-265 **George Martin Fell Brown*** (brown@math.wisc.edu). *Leonard triples associated with hypercubes and their antipodal quotients.*

Let $\mathcal{A}$ be the unital associative algebra over $\mathbb{C}$ with generators x, y, z and relations $xy+yx = 2z$, $yz+zy = 2x$ and $zx + xz = 2y$. We find the finite-dimensional irreducible $\mathcal{A}$-modules and show that x, y, z act on these modules as bipartite or almost bipartite Leonard triples. We define an operator s on finite-dimensional $\mathfrak{sl}_2$-modules that gives them an $\mathcal{A}$-structure.

Let d denote a nonnegative integer and let Q_d denote the graph of the d-dimensional hypercube. It is known that the Terwilliger algebra of Q_d has an $\mathfrak{sl}_2$-module structure. When d is even, we show that applying s to the Terwilliger algebra of Q_d produces the Terwilliger algebra of the alternate Q-polynomial structure of Q_d. When D is odd, we show that applying s to the Terwilliger algebra of Q_d produces the Terwilliger algebra of the antipodal quotient of Q_d. (Received August 22, 2011)

1074-05-271 **Joshua N. Cooper** (cooper@math.sc.edu), Columbia, SC, **Robert B. Ellis*** (rellis@math.iit.edu), Chicago, IL 60616, and **Daniel Tietzer** (dtietzer@iit.edu) and **James Williamson** (jwilli18@iit.edu). *Identification of strategies for liar-type games via discrepancy from their linear approximations.* Preliminary report.

A liar game is a 2-person perfect information played by Paul and Carole in which Paul uses Yes-No questions to find a distinguished element known by Carole, and Carole is allowed to lie a prescribed number of times. Liar games were introduced by Renyi and Ulam, and in an equivalent form, by Berlekamp. In the pathological variant, Paul plays to preserve possibilities for the distinguished element, while Carole plays to disqualify all possibilities. The original and pathological variants are equivalent to adaptive error-correcting and adaptive covering codes, respectively. Good strategies for the pathological variant, when the number of lies is a constant fraction of the total number of questions, have been found by comparison of the game to its linear approximation, called the "liar machine." We describe recent progress in this area, including extension to q-ary from binary Yes-No responses, and to a more general framework corresponding to group testing or pooling. Joint work with Joshua Cooper, Daniel Tietzer, and James Williamson. (Received August 23, 2011)

1074-05-272 **Jason Williford*** (jwillif1@uwyo.edu), University of Wyoming, Dept 3036, 1000 E. University Avenue, Laramie, WY 82071. *Extensions of the Theory of Association Schemes to Coherent Configurations.*

A coherent configuration is a generalization of an association scheme where the identity relation is permitted to be a union of the given relations. Many interesting objects in finite geometry, design theory, and coding theory can be described as association schemes and/or coherent configurations. One advantage of such a description is that theory of association schemes provides certain tools for ruling out the existence of hypothetical objects and hypothetical substructures of known objects. In this talk I will discuss some extensions of these tools to coherent configurations, with applications to certain combinatorial objects. This is joint work with Sylvia Hobart. (Received August 23, 2011)

1074-05-277 **Rebecca I. Swanson*** (rswanson@nebrwesleyan.edu), 5000 Saint Paul Ave., Nebraska Wesleyan University, Dept. of Mathematics and Computer Science, Lincoln, NE. *Combinatorial Proofs of Some Chromatic Polynomial Constraints.* Preliminary report.

For the past century, chromatic polynomials have been studied in depth. The problem of determining exactly which polynomials are chromatic polynomials remains an interesting open question. In 2001, Steingrimsson introduced a class of simplicial complexes called coloring complexes and showed that a quantity associated to a graph's coloring complex, called the h-vector, encodes the graph's chromatic polynomial. Since then, a mixture of topology, geometry, combinatorics, and commutative algebra has been used to study coloring complexes and provide new insights into restrictions upon chromatic polynomials. It remains to construct combinatorial proofs

for these restrictions. In this talk, we shall discuss these known constraints and present combinatorial proofs of the first few as an opening step in this large open question. (Received August 23, 2011)

1074-05-278 **A. Kostochka** and **M. Yancey*** (yancey1@illinois.edu). *Large Rainbow Matchings in Graphs.*

A *rainbow matching* in an edge-colored graph is a matching in which all the edges have distinct colors. For vertex v, let $\hat{d}(v)$ be the *color degree* of v, or the number of distinct colors on the edges incident to v. Let $\hat{\delta}(G)$ be the minimum color degree among vertices of G. We present several anti-Ramsey results about $rm(G)$, the size of the largest rainbow matching in G. We prove the conjecture by Wang and Li that $rm(G) \geq \left\lceil \frac{k}{2} \right\rceil$ when $\hat{\delta}(G) \geq k \geq 4$. We further show that $rm(G) \geq \hat{\delta}(G)$ when $n > 50\hat{\delta}(G)^3$. Both results are sharp. (Received August 23, 2011)

1074-05-287 **Joshua N Cooper*** (cooper@math.sc.edu), 1523 Greene St, LeConte College, USC, Columbia, SC 29208, and **Aaron Dutle**. *Spectra of Hypergraphs.*

Title: Spectra of Hypergraphs

Abstract: We present a spectral theory of hypergraphs that closely parallels graph (adjacency) spectral theory. Classic work by Gelfand-Kapranov-Zelevinsky and Canny, as well as more recent developments by Chang, Lim, Pearson, Qi, Zhang, and others has led to a rich understanding of "hyperdeterminants" of hypermatrices, a.k.a. multidimensional arrays. Hyperdeterminants share many properties with determinants, but the context of multilinear algebra is substantially more complicated than the linear algebra required to understand spectral graph theory (i.e., ordinary matrices). Nonetheless, it is possible to define eigenvalues of a tensor via its characteristic polynomial and variationally. We apply this notion to the "adjacency hypermatrix" of a uniform hypergraph, and prove a number of natural analogues of graph theoretic results. Computations are particularly cumbersome with hyperdeterminants, so we discuss software developed in Sage which can perform basic calculations on small hypergraphs. Open problems abound, and we present several directions for further research.

Joint work with Aaron Dutle of the University of South Carolina. (Received August 23, 2011)

1074-05-301 **Sylvia A. Hobart*** (sahobart@uwyo.edu), Department of Mathematics, University of Wyoming, Dept. 3036, 1000 E. University Avenue, Laramie, WY 82071. *Constructions of coherent configurations from finite geometries.* Preliminary report.

A coherent configuration can be thought of as a system of linked association schemes with nice regularity properties. There are many constructions of association schemes from finite geometries which give useful bounds and nonexistence conditions; an example is the point graph of a partial geometry. Many previous constructions of c.c.'s are linkings of the association schemes on points and lines.

I will describe some new constructions of coherent configurations which result from partitioning the points, in various classes of partial geometries, and show how the theory of coherent configurations may be used to give structural information. (Received August 23, 2011)

1074-05-302 **William B. Kinnersley*** (wkinner2@illinois.edu), **Kevin G. Milans** and **Douglas B. West**. *Degree Ramsey numbers of double-stars.*

We say that H *s-arrows* G when every s-edge-coloring of H contains a monochromatic G. Ramsey's Theorem implies that for every graph G, some sufficiently large complete graph s-arrows G. However, when G is sparse, perhaps some sparse graphs s-arrow G. The *s-color degree Ramsey number* of G is the minimum, over all H that s-arrow G, of $\Delta(H)$. When G is a tree, Jiang showed that the s-color degree Ramsey number of G is at most $2s(\Delta(G) - 1)$. Using Ramanujan graphs and the probabilistic method, we determine the degree Ramsey numbers of large double-stars; as a consequence, we establish the asymptotic tightness of Jiang's bound. This is joint work with Kevin G. Milans and Douglas B. West. (Received August 23, 2011)

1074-05-312 **Michael W Schroeder*** (schroederm@marshall.edu), Marshall University, Huntington, WV 25755, **Richard A Brualdi** (brualdi@math.wisc.edu), Madison, WI 53706, **Kathleen P Kiernan** (kiernan@math.wisc.edu), Madison, WI 53706, and **Seth A Meyer** (smeyer@math.wisc.edu), Madison, WI 53706. *Cyclic Matching Sequencibility of Graphs.* Preliminary report.

Let G be a graph with m edges. The *matching number* of a linear ordering $1, \ldots, m$ of the edges of G is the largest number d such that each consecutive d edges form a matching. The *matching sequencibility* (ms) of G is the largest such d over all orderings. This concept was coined by Alspach in a paper from 2008.

The *cycle matching number* of a cyclic ordering $1, \ldots, m, 1$ of the edges of G is the largest number d such that each consecutive d edges in the cyclic ordering form a matching, and the *cycle matching sequencibility* (cms) of a graph is similarly defined.

We will review what is known and give results involving cms. (Received August 23, 2011)

1074-05-315 **Sung Y. Song*** (sysong@iastate.edu), Department of Mathematics, Iowa State University, Ames, IA 50011-2061. *Directed strongly regular graphs defined on the flags and antiflags of finite incidence structures.* Preliminary report.

There are many ways to define directed regular graphs on the set of flags or on the set of antiflags of a finite incidence structure. Many instances, the resulting digraphs become directed strongly regular or doubly regular. We characterize the incidence structures that produce certain family of directed strongly regular graphs under some of the known construction methods. (Received August 23, 2011)

1074-05-318 **Hemanshu Kaul*** (kaul@iit.edu), Applied Mathematics Dept., E1 Building, 10 W 32nd St., Chicago, IL 60616. *Finding Large Induced Subgraphs.* Preliminary report.

Given a graph, we are interested in studying the problem of finding an induced subgraph of a fixed order with largest number of edges. More generally, let $G = (V, E)$ be an undirected graph, with a weight (budget) function on the vertices, $w : V \to \mathbb{Z}^+$, and a benefit function on vertices and edges $b : E \cup V \to \mathbb{Z}$. The benefit of a subgraph $H = (V_H, E_H)$ is $b(H) = \sum_{v \in V_H} b(v) + \sum_{e \in E_H} b(e)$ while its weight is $w(H) = \sum_{v \in V_H} w(v)$. What can be said about the maximum benefit of an induced subgraph with the restriction that its weight is less than W?

This problem is closely related to the Quadratic Knapsack Problem, the Densest Subgraph Problem, and classical problems in Extremal Graph Theory. We will discuss these connections and new results on approximation algorithms and extremal functions for this problem. (Received August 23, 2011)

1074-05-319 **Sarah R. Bockting*** (bockting@math.wisc.edu), 480 Lincoln Drive, Madison, WI 53706-1388. *Two commuting operators associated with a tridiagonal pair.*

Let $\mathbb{K}$ denote a field and let V denote a vector space over $\mathbb{K}$ with finite positive dimension. We consider an ordered pair of linear transformations $A : V \to V$ and $A^* : V \to V$ that satisfy the following conditions: (i) Each of A, A^* is diagonalizable; (ii) there exists an ordering $\{V_i\}_{i=0}^d$ of the eigenspaces of A such that $A^* V_i \subseteq V_{i-1} + V_i + V_{i+1}$ for $0 \leq i \leq d$, where $V_{-1} = 0$ and $V_{d+1} = 0$; (iii) there exists an ordering $\{V_i^*\}_{i=0}^\delta$ of the eigenspaces of A^* such that $AV_i^* \subseteq V_{i-1}^* + V_i^* + V_{i+1}^*$ for $0 \leq i \leq \delta$, where $V_{-1}^* = 0$ and $V_{\delta+1}^* = 0$; (iv) there does not exist a subspace W of V such that $AW \subseteq W$, $A^*W \subseteq W$, $W \neq 0$, $W \neq V$. We call such a pair a *tridiagonal pair* on V. We define two related linear transformations Δ, Ψ with certain attractive properties. We characterize Δ, Ψ in several ways and discuss their actions on various decompositions of V. (Received August 23, 2011)

1074-05-334 **Luke Bayens*** (bayens@math.colostate.edu), 101 Weber Building, Colorado State University, Fort Collins, CO 80523-1874. *Hemisystems in Unitary Spaces.*

A hemisystem H of a finite nondegenerate unitary space is a set of maximal totally isotropic subspaces such that for every totally isotropic point P, exactly half of the maximals on P are in H. Hemisystems were introduced by Segre in 1965. He constructed a hemisystem of $H(3, 3^2)$ and rasied the question of their existence in other spaces. In 2005, Cossidente and Penttila constructed a family of hemisystems in $H(3, q^2)$, q odd. In 2009, the same authors constructed a family of hemisystem in $H(5, q^2)$, q odd. This talk will discuss some basic properties of hemisystems, and outline a new approach that generalizes the previous constructions of hemisystems to $H(2n-1, q^2)$, q odd. (Received August 24, 2011)

11 ► Number theory

1074-11-2 **A. C. Cojocaru*** (cojocaru@math.uic.edu), University of Illinois at Chicago, Department of Mathematics, Chicago, IL 60606. *Questions about the reductions modulo primes of an elliptic curve.*

Many remarkable questions about prime numbers have natural analogues in the context of elliptic curves. Among them, Artin's primitive root conjecture, the twin prime conjecture, and the Schinzel hypothesis have inspired a broad family of conjectures regarding the behavior of the reductions modulo primes of an elliptic curve over Q. I will give an overview of such questions and progress made towards their resolution. (Received May 25, 2011)

1074-11-3 **Michael E. Zieve*** (zieve@umich.edu), Department of Mathematics, University of Michigan, 530 Church Street, Ann Arbor, MI 48109-1043. *The happy marriage between arithmetic geometry and dynamical systems.*

The past two decades have witnessed the discovery of new connections between dynamical systems, number theory, and algebraic geometry. This has led to new results about complex dynamical systems, new results about maps on rational points induced by morphisms between algebraic varieties, and dynamical generalizations of major results about algebraic groups. I will explain these developments, with a focus on polynomials in one variable. (Received May 21, 2011)

1074-11-24 **Iraj Kalantari** (i-kalantari@wiu.edu), Department of Mathematics, Western Illinois University, 1 University Circle, Macomb, IL 61455, and **Mojtaba Moniri*** (m-moniri@wiu.edu), Department of Mathematics, Western Illinois University, 1 University Circle, Macomb, IL 61455. *On certain quadratic irrational cosines and transcendence of the angle over π.* Preliminary report.

As recently observed by Jahnel, there are only eight quadratic irrationals that are values of the cosine function at rational multiples of π. They are just the familiar ones $\pm\frac{1}{2}\sqrt{2}$, $\pm\frac{1}{2}\sqrt{3}$, and $\pm\frac{1}{4}\pm\frac{1}{4}\sqrt{5}$. In increasing order, the fractional part of the quotient of the angle over π must be either 1/6, 1/5, 1/4, 2/5, 3/5, 3/4, 4/5, or 5/6. For a certain family of quadratic irrationals that we present as values of the cosine function, we improve the irrationality result above to transcendence of the corresponding angle over π. This is established by showing that the transcendence criteria of Adamczewski and Bugeaud apply. We show very feasible computations of various representations of our angles over π.

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S. Plouffe, The computation of certain numbers using a ruler and compass, J. Integer Sequences, V. 1 (1998) Article 98.1.3. (Received June 28, 2011)

1074-11-30 **David Keyes*** (david.keyes@colorado.edu), 3535 28th Street Apt 103, Boulder, CO 80301. *$\mathbb{F}_p$-codes, theta series, and the Hamming weight MacWilliams identity.*

We provide an analytic proof of the Hamming weight MacWilliams Identity for linear $\mathbb{F}_p$-codes via theta series inversion formulas. This generalizes the work of Hirzebruch, van der Geer, Choie, and Jeong for the Lee weight enumerator. (Received July 13, 2011)

1074-11-41 **Luis Finotti*** (finotti@math.utk.edu), Department of Mathematics, UTK, 1403 Circle Drive, Knoxville, TN 37996. *Efficient computations with Witt vectors.*

Some codes can be constructed using lifting of curves over finite fields to curves over the rings of Witt vectors. But, except in cases when we have a canonical isomorphism of these rings onto simpler rings, computations with Witt vector can be quite demanding. We will discuss how to obtain significant improvements with general computations with Witt vectors, and, time permitting, show some applications. (Received July 22, 2011)

1074-11-70 **C. Douglas Haessig*** (chaessig@math.rochester.edu). *L-functions of families of toric exponential sums.*

In this talk, I will discuss L-functions coming from linear algebraic operations on relative p-adic cohomology for a general family of toric exponential sums. With the aid of the 'relative polytope' associated to the family, bounds on degree, total degree, and p-divisibility will be given. Similar results for affine families, pure archimedean weight families, and p-adic unit root families will also be discussed. This is joint work with Steven Sperber. (Received August 08, 2011)

1074-11-74 **Nigel Boston*** (boston@math.wisc.edu), Department of Mathematics, University of Wisconsin, Madison, WI 53706. *Non-abelian Cohen-Lenstra Heuristics.*

In 1983, Cohen and Lenstra observed that the frequency with which a given abelian p-group A (p odd) arises as the p-class group of an imaginary quadratic field K is apparently proportional to $1/|\mathrm{Aut}(A)|$. The Galois group of the maximal unramified p-extension of K has abelianization A and one might then ask how frequently a given p-group G arises. We develop a theory wherein this frequency is inversely proportional to the size of its automorphism group in a new category and then test this against computations. If time permits, I shall describe

progress on the real quadratic case. This is joint work with Michael Bush and Farshid Hajir. (Received August 09, 2011)

1074-11-99 **Bob Guralnick**, **Beth Malmskog** and **Rachel Pries*** (pries@math.colostate.edu). *Automorphism groups of a family of maximal curves.*

The Hasse Weil bound restricts the number of points of a curve which are defined over a finite field; if the number of points meets this bound, the curve is called maximal. Giulietti and Korchmaros introduced a curve C_3 which is maximal over F_{q^6} and determined its automorphism group. Garcia, Guneri, and Stichtenoth generalized this construction to a family of curves C_n, indexed by an odd integer $n \geq 3$, such that C_n is maximal over $F_{q^{2n}}$. In this talk, I will first explain why this family of maximal curves is interesting and then describe recent work with Guralnick and Malmskog in which we determine the automorphism group $Aut(C_n)$ when $n > 3$; in contrast with the case $n = 3$, the automorphism group fixes the point at infinity on C_n. The proof uses ramification theory and a new structural result about automorphism groups of curves in characteristic p such that each Sylow p-subgroup has exactly one fixed point. (Received August 12, 2011)

1074-11-171 **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 with complex multiplication.*

Let $\Theta(D)$ be the vector space generated by the theta series attached to the positive binary quadratic forms of discriminant D/t^2, where t is some integer. The main aim of this talk is to show that $\Theta(D)$ equals the space of modular forms of weight 1 and of level $|D|$ which have complex multiplication (CM) by their Nebentypus character ψ_D (= the Legendre-Kronecker character). One key step here is to give (via the Deligne-Serre theory) a Galois-theoretic interpretation of newforms of weight 1 with complex multiplication. Another step consists of a careful analysis of how each such theta series can be expressed as a linear combination of the (extended) Atkin-Lehner basis for modular forms of weight one. (Received August 19, 2011)

1074-11-187 **Farshid Hajir*** (hajir@math.umass.edu), Dept of Mathematics & Statistics, University of Massachusetts, Amherst, Amherst, MA 01003. *Asymptotically Good Families of Codes, Curves, Graphs, Number Fields, and 3-manifolds.*

There is a common thread connecting certain types of problems about objects with extremal properties in numerous branches of mathematics. I will discuss a common framework for such problems. Most of the talk is expository in nature and I will focus on the case of codes as the lead illustrative example, but near the end I will describe how the common framework leads to some unsolved problems about hyperbolic 3-manifolds. (Received August 23, 2011)

1074-11-188 **Jeff Achter*** (achter@math.colostate.edu), Department of Mathematics, Fort Collins, CO 80523-1874. *A conjecture of Lang-Trotter type for abelian surfaces.* Preliminary report.

Let X be an absolutely simple abelian variety over a number field. Then X may or may not have absolutely simple reduction almost everywhere; Murty and Patankar conjecture that this depends only on the (commutativity of the) endomorphism ring of X. I'll discuss recent work on this problem and on a refinement, which hopes to capture the rate of growth of the set of exceptional primes. (Received August 20, 2011)

1074-11-205 **David Grant*** (grant@colorado.edu), Department of Mathematics, University of Colorado at Boulder, Campus Box 395, Boulder, CO 80309, and **Su-Ion Ih**. *Integral Division Points on Curves.*

(Joint work with Su-ion Ih) Let k be a number field with algebraic closure $\overline{k}$, and let S be a finite set of primes of k containing all the infinite ones. Let E/k be an elliptic curve, Γ_0 be a finitely generated subgroup of $E(\overline{k})$, and $\Gamma \subseteq E(\overline{k})$ be the division group attached to Γ_0. Fix an effective divisor D of E with support containing either (i) at least two points whose difference is not torsion, or (ii) at least one point not in Γ. We prove that the set of "integral division points on $E(\overline{k})$," i.e., the set of points of Γ which are S-integral on E relative to D, is finite.

We also prove the $\mathbb{G}_{\mathrm{m}}$-analogue of this theorem, thereby establishing the 1-dimensional case of a general conjecture we pose on integral division points on semi-abelian varieties. (Received August 21, 2011)

1074-11-235 **Jordan S. Ellenberg** (ellenber@math.wisc.edu), **Chris Hall*** (chall14@uwyo.edu) and **Emmanuel Kowalski** (kowalski@math.ethz.ch). *Expander Graphs in Arithmetic Geometry.*

Hilbert's irreducibility theorem implies that for an irreducible polynomial f in $\mathbb{Q}[t, x]$ there are infinitely many rational specializations $t = t_0$ for which the specialized polynomial f_0 is also irreducible. If we regard f as a

polynomial over the rational function field $K = \mathbb{Q}(t)$, then one can also ask refined questions, e.g. whether or not f and f_0 have the same Galois group. Given an a simple abelian variety A over K, one can regard it as a one-parameter family of abelian varieties over $\mathbb{Q}$, and one can ask for which rational numbers $t = t_0$ the specialized abelian variety A_0 is also simple. We will explain one way to approach this question and how recent developments in expander graphs play a crucial role. (Received August 22, 2011)

1074-11-289 **H Kim*** (hkim@suno.edu). *New type of multiplicative relations of Gauss sums.*
In this paper, we study the multiplicative relations of Gauss sums, investigate a new type of multiplicative relations, and decide explicitly ambiguous signs. (Received August 23, 2011)

13 ► Commutative rings and algebras

1074-13-8 **Paolo Mantero*** (pmantero@math.purdue.edu) and **Yu Xie** (yxie@nd.edu). *On the Cohen-Macaulayness of the conormal module of an ideal.*
In this talk we investigate a question stemming from a long-standing conjecture of Vasconcelos: given a generically complete intersection perfect ideal I in a regular local ring R, when is it true that the Cohen-Macaulayness of I/I^2 (or R/I^2) implies that R/I is Gorenstein? This property is known to hold for licci ideals and, essentially, squarefree monomial ideals. We show that a positive answer actually holds for every monomial ideal. We then give a positive answer for several special classes of ideals and provide application to algebroid curves with low multiplicity. We also exhibit prime ideals in regular local rings and homogeneous level ideals in polynomial rings for which the answer is negative and use them to show the sharpness of our main result, as they lie in the first class of ideals not covered by it. The homogeneous examples have been found thanks to the help of J. C. Migliore. As a by-product, we exhibit several classes of Cohen-Macaulay ideals whose square is not Cohen-Macaulay. Our methods work both in the homogeneous and in the local settings. (Received June 19, 2011)

1074-13-33 **Mashhoor A. Refai*** (m.refai@psut.edu.jo). *On Augmented Graded Rings.*
On Augmented Graded Rings Mashhoor Refai Professor of Mathematics Vice President for Academic Affairs Princess Sumaya University for Technology Amman, Jordan E-mail: m.refai@psut.edu.jo Abstract Let G be a group with identity e, and R be a ring with unity 1 different from 0. Then R is a G-graded ring if there exist additive subgroups Rg of R indexed by the elements g 2 G such that R = M g2G Rg and RgRh = Rgh for all g, h 2 G. We say that R is a strongly graded ring if RgRh = Rgh for all g, h 2 G. This is equivalent to 1 2 RgRg–'1 for all g 2 G. In 1995, we defined three successively stronger properties that a grading may have, and we investigated the relationship between these strong gradings and the stronger non-degenerate and faithful properties which are motivated by the work of Cohen and Rowen. In this paper, we study some properties of augmented graded rings and give the relationships between augmented graded rings and other types of well known strongly graded rings. A survey of my contribution to the field, will also be given. 1 (Received July 17, 2011)

1074-13-34 **Fabrizio Zanello*** (zanello@math.mit.edu), Department of Mathematics, MIT, Office 2-336, Cambridge, MA 02139. *On the interval property in algebra and combinatorics.*
A class S of integer sequences has the *Interval Property* if, when $h, h' \in S$ coincide in all entries but one, say $h = (h_0, \dots, h_{i-1}, h_i, h_{i+1}, \dots)$ and $h' = (h_0, \dots, h_{i-1}, h_i + a, h_{i+1}, \dots)$ for some $a \geq 1$, then $(h_0, \dots, h_{i-1}, h_i + b, h_{i+1}, \dots)$ is also in S, for each $b = 1, 2, \dots, a-1$.

The Interval Property turns out to be a strong and natural structural property to look for for certain integer sequences, especially when their full characterization is out of reach. It has recently been studied or conjectured in several contexts of interest in graded commutative algebra and combinatorics. In some specific cases it has been shown to hold or to fail, but in most instances it is still a known unknown.

Classes of sequences with respect to which I will discuss the Interval Property include: the Hilbert functions of graded level and Gorenstein algebras, where this property was first introduced (myself, J. Algebra, 2009); pure O-sequences (an upcoming AMS Memoir, joint with M. Boij, J. Migliore, R. Miró-Roig and U. Nagel); f-vectors of pure simplicial complexes (the same Memoir); matroid h-vectors (a joint preprint with T. Há and E. Stokes); the rank functions of r-differential posets (a joint work in preparation with R. Stanley). (Received July 17, 2011)

1074-13-42 **David E. Dobbs*** (dobbs@math.utk.edu), Department of Mathematics, University of Tennessee, Knoxville, TN 37996-1320, and **Gabriel Picavet** and **Martine Picavet-L'Hermitte**. *Characterizing the ring extensions that satisfy FIP or FCP.*

Several parallel characterizations of the FIP and FCP properties are given. Also, a number of results about FCP are generalized from domains to arbitrary (commutative) rings. Let $R \subseteq S$ be rings, with $\overline{R}$ the integral closure of R in S. Then $R \subseteq S$ satisfies FIP (resp., FCP) if and only if both $R \subseteq \overline{R}$ and $\overline{R} \subseteq S$ satisfy FIP (resp., FCP). If R is integrally closed in S, then $R \subseteq S$ satisfies FIP $\Leftrightarrow$ $R \subseteq S$ satisfies FCP $\Leftrightarrow$ (R, S) is a normal pair such that $\mathrm{Supp}_R(S/R)$ is finite. If $R \subseteq S$ is integral and has conductor C, then $R \subseteq S$ satisfies FCP if and only if S is a finitely generated R-module such that R/C is an Artinian ring. The characterizations of FIP and FCP for integral extensions feature natural roles for the intermediate rings arising from seminormalization and t-closure. (Received July 27, 2011)

1074-13-46 **Lee Klingler*** (klingler@fau.edu), Department of Mathematical Sciences, 777 Glades Road, Boca Raton, FL 33431, and **Yuri Villanueva**, Department of Mathematical Sciences, 777 Glades Road, Boca Raton, FL 33431. *On the number of generators for ideals in rings of integer-valued polynomials.* Preliminary report.

For integral domain D with field of fractions K and subset $E \subseteq D$, the ring $\mathrm{Int}(E, D) = \{f \in K | f(E) \subseteq D\}$ of integer-valued polynomials on E has been well-studied. In particular, when E is finite, Chapman, Loper and Smith, as well as Boynton and Klingler, obtained a bound on the number of generators needed for finitely generated ideals of $\mathrm{Int}(E, D)$ in terms of the corresponding bound for D. We obtain analogous results for the ring of integer-valued derivatives $\mathrm{Int}^{(r)}(E, D) = \{f \in K | f^{(k)}(E) \subseteq D \text{ forall } 0 \leq k \leq r\}$, for fixed integer $r \geq 1$. (Received August 01, 2011)

1074-13-50 **Ryo Takahashi*** (takahasi@math.shinshu-u.ac.jp), Matsumoto, Nagano 390-8621, Japan. *Dimensions of derived categories and singularity categories.*

The notion of the dimension of a triangulated category has been introduced by Bondal, Rouquier and Van den Bergh. In this talk, for a commutative noetherian ring R we study upper/lower bounds for the dimensions of the bounded derived category of finite R-modules and the singularity categories of R. This is joint work with Takuma Aihara. (Received August 03, 2011)

1074-13-57 **Craig Huneke*** (huneke@math.ku.edu), Department of Mathematics, Lawrence, KS 66045, and **Krishna Hanumanthu**. *Bounds on the first Hilbert coefficient.*

We present new bounds for the first Hilbert coefficient of an m-primary ideal in a local Noetherian ring (R,m). The bounds are quadratic in the multiplicity of the ideal. (Received August 05, 2011)

1074-13-59 **Craig Huneke*** (huneke@math.ku.edu), Department of Mathematics, University of Kansas, Lawrence, KS 66045, and **Brian Harbourne**, Department of Mathematics, University of Nebraska, Lincoln, NE. *Questions on symbolic powers.*

This talk will discuss several questions recently raised in a paper of Brian Harbourne and myself concerning the behavior of symbolic powers of primes in polynomial rings. Some partial results will be given. (Received August 07, 2011)

1074-13-71 **Nicholas R Baeth*** (baeth@ucmo.edu), W.C. Morris 213, University of Central Missouri, Warrensburg, MO 64064. *Factorization theory and decompositions of modules.* Preliminary report.

The study of direct-sum decompositions of modules and the study of factorization in monoids have developed separately over the past fifty years. During the last decade, techniques in monoid theory have been used in order to understand direct-sum decompositions of modules. In particular, various monoid-theoretic invariants have been used to describe the uniqueness and non-uniqueness of direct-sum decompositions over certain commutative Noetherian local rings. In this talk we will discuss how one can represent direct-sum decomposition in terms of factorization in a commutative monoid. We will then consider information given by these monoids including new invariants whose study may lead to a solution to a long-studied question about modules over commutative rings. (Received August 09, 2011)

1074-13-76 **Sean Sather-Wagstaff*** (sean.sather-wagstaff@ndsu.edu) and **Saeed Nasseh**. *A theorem in representation theory for DG algebras, with an application to a question of Vasconcelos.* Preliminary report.

Let F be an algebraically closed field, and let R be a finite dimensional commutative F-algebra. Given an integer $n \geq 1$, let $\mathrm{Mod}(F^n, R)$ denote the set of R-module structures on F^n. This is an algebraic variety over

F, and the general linear group $G = \mathrm{GL}_n(F)$ acts on $\mathrm{Mod}(F^n, R)$, essentially by conjugation. Given an element $M \in \mathrm{Mod}(F^n, R)$, let $T(M)$ denote the Zariski tangent space to $\mathrm{Mod}(F^n, R)$ at M, and let $T_0(M)$ denote the Zariski tangent space to the orbit $G.M$ at M.

An (apparently) well-known theorem in representation theory says that there is an isomorphism $\mathrm{Ext}^1_R(M, M) \cong T(M)/T_0(M)$. We will discuss the ideas behind the proof of this theorem, *à la* Gabriel. Then we will present an extension to the case where R is replaced with a finite dimensional commutative DG algebra, and M is a bounded DG R-module. Finally, we will discuss an application to a question of Vasconcelos about semidualizing modules over noetherian local rings. (Received August 09, 2011)

1074-13-77 **Tai H Ha*** (tha@tulane.edu), Tulane University, Department of Mathematics, 6823 St. Charles Ave., New Orleans, LA 70118. *Stabilization of multigraded Betti numbers.*

Let G be a finitely generated abelian group and let S be a G-graded polynomial ring. Let $I \subset S$ be a G-homogeneous ideal and let M be a finitely generated G-graded S-module. In this talk, we examine the asymptotic behavior of the G-graded Betti table of $I^n M$ as n gets large. (Received August 10, 2011)

1074-13-79 **Courtney Gibbons*** (s-cgibbon5@math.unl.edu), University of Nebraska-Lincoln, Department of Mathematics, 203 Avery Hall, PO Box 881030, Lincoln, NE 68588-0130. *New Directions in Boij-Söderberg Theory.*

Boij and Söderberg's conjectures, now theorems, provide unusual new tools for analyzing Betti diagrams of finitely generated modules over standard graded polynomial rings. Few examples exist that extend the theory to other graded rings or classify the Betti diagram decompositions of specific classes of modules over the polynomial ring. I will discuss some new results in these directions. (Received August 10, 2011)

1074-13-80 **D. D. Anderson*** (dan-anderson@uiowa.edu), Department of Mathematics, The University of Iowa, Iowa City, IA 52242, and **Sangmin Chun** (schun@snu.ac.kr), Department of Mathematics, Seoul National University, Seoul, 151-747, South Korea. *Ideals that are an irredundant union of principal ideals.*

We investigate ideals of a commutative ring that are an irredundant union of principal ideals. Special attention is paid to prime ideals that are a finite union of principal ideals. (Received August 10, 2011)

1074-13-84 **Enrico Carlini*** (enrico.carlini@polito.it), Corso Duca degli Abruzzi 24, 10129 Turin, Italy, and **Maria Virginia Catalisano** and **Anthony V. Geramita**. *Monomials as sums of powers - Part I.*

In the polynomial ring $T = k[y_1, \ldots, y_n]$, with $n > 1$ we study the ideals $I \subset (y_1^{a_1}, \ldots, y_n^{a_n})$ such that T/I has dimension one. In particular, we produce a bound on their multiplicity. As a corollary, we show that the monomial $x_1^{b_1} \cdot \ldots \cdot x_n^{b_n}$, with $1 \leq b_1 \leq \ldots \leq b_n$ is the sum of $\prod_2^n (b_i + 1)$ powers of linear forms and no fewer. (Received August 14, 2011)

1074-13-87 **Christopher Francisco*** (chris@math.okstate.edu), **Jeffrey Mermin** and **Jay Schweig**. *Generalizing the Borel condition.* Preliminary report.

We introduce the idea of a monomial ideal in $k[x_1, \ldots, x_n]$ being Borel with respect to a poset on $x_1, \ldots, x_n$. Using this perspective, we investigate the influence of the poset on free resolutions, primary decompositions, and other standard objects of interest in commutative algebra. (Received August 11, 2011)

1074-13-89 **Andrew R. Kustin*** (kustin@math.sc.edu), **Claudia Polini** and **Bernd Ulrich**. *The bi-graded structure of Symmetric Algebras with applications to Rees rings.*

Let k be a field, $R = k[x, y]$, and I a height 2 ideal of R minimally generated by 3 forms, g_1, g_2, g_3 of degree d. Let φ be a homogeneous Hilbert-Burch matrix for I; each entry in column i of φ has degree d_i, with $d_1 < d_2$. Let $\mathcal{A}$ be the kernel of the natural surjection

$$\mathrm{Sym}(I) \twoheadrightarrow \mathcal{R}$$

from the symmetric algebra of I to the Rees algebra and let S and B be the polynomial rings $S = k[T_1, T_2, T_3]$ and $B = k[x, y, T_1, T_2, T_3]$. View B as a bi-graded k-algebra, where x and y have bi-degree $(1, 0)$ and each T_i has bi-degree $(0, 1)$. We describe the S-module structure of $\mathcal{A}_{(*, \geq d_1 - 1)}$ under the hypothesis that φ has a generalized zero in column one. When one views this result in a geometric context, that is,

$$[g_1, g_2, g_3] : \mathbb{P}^1 \to \mathcal{C} \subseteq \mathbb{P}^2$$

is a birational parameterization of a plane curve, then Bi-Proj $\mathcal{R}$ is the graph, Γ, of the parameterization of $\mathcal{C}$, the hypothesis concerning the generalized zero is equivalent to assuming that $\mathcal{C}$ has a singularity of multiplicity d_1, and $\mathcal{A}_{(*, \geq d_1 - 1)}$ is an approximation of the ideal which defines Γ. (Received August 11, 2011)

1074-13-98 **Evan G Houston*** (eghousto@uncc.edu), Dept. of Mathematics and Statistics, Charlotte, NC 28223. *Star (prime) operations on Noetherian domains.* Preliminary report.

A *star operation* (also called a *prime operation*) on an integral domain R is a closure operation on the set of (fractional) ideals of R which behaves well with respect to principal ideals. For a Noetherian domain R, we discuss both the possible finiteness and the structure of the set of all star operations on R. (Received August 12, 2011)

1074-13-106 **Olgur Celikbas*** (CelikbasO@missouri.edu). *A criterion for the vanishing of homology.* Preliminary report.

I will discuss certain depth conditions on the tensor products of finitely generated modules that force the vanishing of homology over complete intersection rings. (Received August 14, 2011)

1074-13-115 **Zhaobing Fan*** (fanz@math.ksu.edu), 1545 International Court, M 24, Manhattan, KS 66502. *Geometric approach to Hall algebra of representations of Quivers over local ring.*

The category of representations of a Dynkin quiver over local ring $R = k[t]/(t^n)$ is no longer hereditary. The Hall algebra defined on this category doesn't have a well defined coalgebraic structure. In the present paper, the full subcategory of this category, whose objects are the modules assigning free R-module to each vertex, is considered. This full subcategory is an exact category. The Ringel-Hall algebra is well defined on this exact category. There exists a coalgebraic structure on the composition subalgebra of this algebra. The geometric realization of the composition subalgebra of this Hall algebra is given under the framework of Lusztig's geometric setting. Moreover the canonical basis and a monomial basis of this subalgebra are constructed by using preserves sheaves. This generalizes the Lusztig's result about the geometric realization of quantum enveloping algebra. As a byproduct, the relation between this subalgebra and quantum generalized Kac-Moody algebra is obtained. (Received August 15, 2011)

1074-13-117 **Jayanthan V Aryampilly*** (jayanav@iitm.ac.in), Department of Mathematics, Indian Institute of Technology Madras, Chennai, Tamil Nadu 600036, India. *Regularity and Gorensteinness of fiber cone.*

In this talk, we will discuss the Castelnuovo-Mumford regularity and Gorenstein properties of the fiber cone. We obtain upper bounds for the Castelnuovo-Mumford regularity of the fiber cone and obtain sufficient conditions for the regularity of the fiber cone to be equal to that of the Rees algebra. We obtain a formula for the canonical module of the fiber cone and use it to study the Gorenstein property of the fiber cone. (Received August 15, 2011)

1074-13-133 **W. Frank Moore**, **Greg Peipmeyer**, **Mark E. Walker** and **Sandra Spiroff*** (spiroff@olemiss.edu), Department of Mathematics, University of Mississippi, Hume Hall 305, P.O. Box 1848, University, MS 38677. *A Generalized Hochster's Theta Function.*

We study a generalized version of Hochster's theta function, which was defined in the case of a hypersurface, as the difference of the lengths of two consecutive torsion modules. We focus on the case where the ring is a complete intersection with isolated singularity, and in particular restrict our study to graded rings containing a field. We show that, unlike the original theta, this new function always vanishes, and hence has implications regarding rigidity. (Received August 17, 2011)

1074-13-142 **Gregory G Smith*** (ggsmith@mast.queensu.ca), Department of Mathematics and Statistics, Queen's University, Kingston, and **Adam McCabe**, Department of Mathematics, University of Toronto. *Log-concavity of asymptotic multigraded Hilbert series.*

We study the linear map sending the numerator of the multigraded Hilbert series of a module to that of its r-th Veronese submodule. We show that the limit as r tends to infinity exists and essentially depends only on the underlying positively multigraded polynomial ring. We also give a polyhedral description for the limiting polynomial and prove that the coefficients are log-concave. (Received August 18, 2011)

1074-13-146 **Saeed Nasseh*** (saeed.nasseh@ndsu.edu), Department of Mathematics, NDSU Dept 2750, PO Box 6050, Fargo, ND 58108-6050, and **Sean Sather-Wagstaff**. *DG Ext and Yoneda Ext for DG modules.*

In this talk we describe a relation between vanishing of DG Ext and vanishing of Yoneda Ext for differential graded modules over a differential graded algebra. (Received August 18, 2011)

1074-13-154 **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. *Rees algebras of square-free monomial ideals.* Preliminary report.

We will discuss a construction that enables us to determine the defining equations of the Rees algebra for certain square-free monomial ideals in a polynomial ring over a field. We also determine specific classes of square-free monomial ideals that are of linear type. (Received August 19, 2011)

1074-13-161 **Sara Faridi*** (faridi@dal.ca). *Resolutions of monomial ideals using simplicial trees.* Preliminary report.

The focus of this talk is on resolutions of monomial ideals. More specifically, for certain classes of ideals, we use the structure of a simplicial tree and certain orderings of the generators of the ideal to provide recursive formulas for computing the Betti numbers. (Received August 19, 2011)

1074-13-163 **Andy Kustin** and **Adela Vraciu***, vraciu@math.sc.edu. *The weak Lefschetz property for monomial complete intersections in positive characteristic.*

The weak Lefschetz property is true for every monomial complete intersection in characteristic zero, but this is not the case in positive characteristic. We give an explicit description of the values of d (depending on the characteristic p) for which $k[x,y,z,w]/(x^d,y^d,z^d,w^d)$ has the weak Lefschetz property when k is a field of characteristic p. The case of three variables has been settled earlier by Brenner and Kaid. For the case of 5 or more variables, we show that $k[x_1,\dots,x_n]/(x_1^d,\dots,x_n^d)$ can only have the weak Lefschetz property when the value of d is small compared to the value of the characteristic. (Received August 19, 2011)

1074-13-165 **Juan Migliore** and **Uwe Nagel*** (uwe.nagel@uky.edu), Department of Mathematics, University of Kentucky, 715 Patterson Office Tower, Lexington, KY 40506. *Gorenstein algebras presented by quadrics.*

We discuss restrictions on the Hilbert function of standard graded Gorenstein algebras with only quadratic relations. Furthermore, we pose some intriguing conjectures and provide evidence for them by proving them in some cases using a number of different techniques, including liaison theory and generic initial ideals. (Received August 19, 2011)

1074-13-198 **Silvia Saccon*** (ssaccon@math.arizona.edu), Department of Mathematics, The University of Arizona, Tucson, AZ 85721-0089, and **Nicholas R. Baeth**, Dept. of Mathematics and Computer Science, University of Central Missouri. *How do maximal Cohen-Macaulay modules behave over rings of infinite Cohen-Macaulay type?*

Given a commutative ring R and a class $\mathcal{C}$ of R-modules closed under isomorphism, finite direct sums and direct summands, one can ask whether every module in $\mathcal{C}$ decomposes uniquely as a direct sum of indecomposable modules in $\mathcal{C}$. We restrict our attention to one-dimensional Noetherian local rings $(R,\mathfrak{m})$ whose $\mathfrak{m}$-adic completion is reduced, and to the class of maximal Cohen-Macaulay R-modules (i.e., non-zero finitely generated torsion-free R-modules). One approach to the study of direct-sum decompositions over R is to describe the monoid $\mathfrak{C}(R)$ of isomorphism classes of maximal Cohen-Macaulay R-modules (together with $[0_R]$) with operation induced by the direct sum. The monoid $\mathfrak{C}(R)$ has been described when R has finite Cohen-Macaulay type. In this talk, I will discuss the structure and properties of the monoid $\mathfrak{C}(R)$ when R has *infinite* Cohen-Macaulay type. (Received August 21, 2011)

1074-13-199 **Alexandra Seceleanu*** (aseceleanu2@math.unl.edu), 203 Avery Hall, Lincoln, NE 68588. *Bounding projective dimension and regularity.*

Recently there has been a surge of interest in the following problem (due to Stillman): is there a bound on the projective dimension or the regularity of an ideal generated by polynomials of degrees $d_1,...,d_n$ which is independent of the number of variables of the ambient polynomial ring?

I shall survey a series of papers (McCullough 2010, Beder-McCullough-Nunez-Seceleanu-Snapp-Stone 2011, Ananyan-Hochster 2011) that suggest that any such bound must exhibit at least exponential growth. (Received August 21, 2011)

1074-13-200 **Bhargav Bhatt** and **Anurag K Singh*** (singh@math.utah.edu), Department of Mathematics, University of Utah, 155 South 1400 East, Salt Lake City, UT 84112. *F-pure thresholds of hypersurfaces.* Preliminary report.

The F-pure threshold is a characteristic p analogue of characteristic zero log canonical thresholds. We will discuss the calculation of F-pure thresholds for supersingular Calabi-Yau hypersurfaces; this is work in progress with Bhargav Bhatt. (Received August 21, 2011)

1074-13-209 **Ryan Karr*** (ryan.d.karr@gmail.com), Jupiter, FL 33458. *The torsion free cancellation problem for the integral group ring $\mathbb{Z}D_{16}$.*

Let $\mathbb{Z}G$ be the integral group ring over a finite group G. We can ask if $\mathbb{Z}G$ has *torsion free cancellation*, that is, if $M \oplus L \cong N \oplus L$ implies $M \cong N$ for all finitely generated torsion free $\mathbb{Z}G$-modules L, M and N. By 1998, the torsion free cancellation question had been settled for all G except the dihedral group D_{16} of order 16. We'll quickly review the work done between 1981 and 1998 on this question, and then look at some recent progress pertaining to $G = D_{16}$, the only case that remains unsettled. (Received August 21, 2011)

1074-13-211 **Karl Kattchee*** (kkattchee@uwlax.edu), University of Wisconsin-La Crosse, 1725 State Street, La Crosse, WI 54601, and **Trever Hallock**. *An Algorithm for Computing Elasticities of Block Monoids.* Preliminary report.

Block monoids are a convenient setting for studying factorization properties of Krull domains, and the elasticity function is one way of measuring the extent to which unique factorization fails. In this talk, an algorithm for computing elasticity is presented, and results of a computer implementation of the algorithm are given. (Received August 22, 2011)

1074-13-212 **Paul-Jean Cahen*** (paul-jean.cahen@univ-cezanne.fr), **David E Dobbs** and **Thomas G Lucas**. *Strong and weak finitely valuative domains.* Preliminary report.

Let R be a domain with quotient field K. For a nonnegative integer n, an element t of K is said to be within n steps resp., strongly within n steps, resp., weakly within n steps of R if there is a saturated chain of rings $R = R_0 \subsetneq R_1 \subsetneq \cdots \subsetneq R_m = R[t]$ with length $m \leq n$ (resp., all saturated chains from R to $R[t]$ have length at most n, resp., $R[t]$ is contained in an overring of R which is within n steps of R). We then generalize the notion of a valuative domain, by saying that R is an n-valuative domain (resp., a strong n-valuative domain; resp., a weak n-valuative domain) if, for each nonzero element $u \in K$, at least one of u and u^{-1} is within n steps (resp., strongly within n steps; resp., weakly within n steps) of R. The integral closure of a weak n-valuative domain is a Prüfer domain. Moreover, a weak n-valuative domain has at most $2n + 1$ maximal ideals; and a weak n-valuative domain with $2n + 1$ maximal ideals must be a Prüfer domain. (Received August 22, 2011)

1074-13-215 **Melvin Hochster*** (hochster@umich.edu), Department of Mathematics, University of Michigan, East Hall, 530 Church Street, Ann Arbor, MI 48109-1043, and **Wenliang Zhang**, Department of Mathematics, University of Michigan, East Hall, 530 Church Street, Ann Arbor, MI 48109-1043. *Target elements and test ideals.*

An element r of a Noetherian domain R is called a target element if for every module-finite extension domain S of R, there is an R-linear map from S to R such that r is in the image. The relationship between target elements and the test ideal for tight closure in characteristic p will be discussed, and in mixed characteristic $p > 0$ it will be shown that whenever a suitable form of the direct summand conjecture holds, if R is complete and normal, the target ideal J is sufficiently large that Rad(J + pR) contains the defining ideal of the singular locus. In particular, this holds in dimension at most 3. A number of other issues connected with splitting module-finite extensions will be discussed. A number of other issues connected with splitting module-finite extensions of local domains will be discussed. (Received August 22, 2011)

1074-13-221 **Bruce M Olberding*** (olberdin@nmsu.edu), Department of Mathematical Sciences, Las Cruces, NM 88011. *Topological and geometric criteria for irredundancy of an intersection of valuation rings.* Preliminary report.

Let F be a field, and let D be a subring of F. The Zariski-Riemann space $\mathrm{Zar}(F/D)$ of the extension F/D is the collection of all valuation rings between D and F having quotient field F, equipped with the Zariski topology. The Zariski-Riemann space has the structure of a locally ringed space but in general is not a scheme. However, using the Kronecker function ring construction, some topological and geometric aspects of $\mathrm{Zar}(F/D)$ can be mirrored by a certain affine scheme. This point of view is helpful in determining whether $\bigcap_{W \in Z} W \subseteq V$, where Z is a subset of $\mathrm{Zar}(F/D)$ and V is a valuation ring in $\mathrm{Zar}(F/D)$. We discuss how this property connects with topological and geometric features of $\mathrm{Zar}(F/D)$. The strongest results are obtained when the valuation rings in Z are centered on points of codimension at most 2 in a projective model of F/D. (Received August 22, 2011)

1074-13-231 **Bethany Kubik*** (bethany.kubik@usma.edu), 601 Thayer Road, Mathematics Dept #222, West Point, NY 10996. *Quasidualing Modules and the Auslander and Bass Classes.* Preliminary report.

Let R be a complete local noetherian ring. An artinian R-module T is *quasidualizing* if $R \cong \mathrm{Hom}_R(T,T)$ and $\mathrm{Ext}_R(T,T) = 0$ for all $i \geq 1$. If T is a quasidualizing module, we say that an R-module M is *derived T-reflexive* if the natural biduality map $M \to \mathrm{Hom}_R(\mathrm{Hom}_R(M,T),T)$ is an isomorphism and one has $\mathrm{Ext}_R(M,T) = 0 = \mathrm{Ext}_R(\mathrm{Hom}_R(M,T),T)$ for all $i \geq 1$. We use Matlis duality to map the relationships between the class of derived T-reflexive modules and the Auslander and Bass classes. (Received August 22, 2011)

1074-13-234 **Lori A McDonnell*** (lmcdonne@ashland.edu), Dept. of Mathematics and Computer Science, Ashland University, Ashland, OH 44805. *Hilbert Coefficients of Parameter Ideals.*

Given a local ring R and a zero-dimensional ideal I, the function $H_I(n) : \mathbb{Z} \to \mathbb{Z}$ defined by $H_I(n) = \lambda_R(R/I^n)$ agrees with a polynomial, called the Hilbert-Samuel polynomial, of degree $d = \dim R$ for large values of n. We will examine the coefficients of this polynomial in the case the ideal I is a parameter ideal. In particular, when the depth of the associated graded ring is at least $d-1$, we will show that the coefficients, $e_i(I)$, are non-positive for $1 \leq i \leq d$. We will also examine the difference between $H_I(n)$ and the Hilbert-Samuel polynomial evaluated at n when I is a parameter ideal. (Received August 22, 2011)

1074-13-240 **Andrew Crabbe** and **Graham J. Leuschke*** (gjleusch@math.syr.edu), 215 Carnegie Library, Syracuse, NY 13244. *Wild Hypersurfaces.*

In the representation theory of finite-dimensional algebras over a field, Drozd's dichotomy theorem says that an algebra has either tame module type or wild module type. Loosely, these two possibilities correspond to having a classification theorem, versus throwing up our hands in despair. We'd like a similar dichotomy result in other representation-theoretic contexts, specifically for maximal Cohen-Macaulay modules over a Cohen-Macaulay local ring. The talk will give a little background on the problem, including definitions of tame and wild CM type, and describe recent work giving a unified proof that hypersurfaces of multiplicity four or more in three or more variables have wild CM type. (Received August 22, 2011)

1074-13-244 **Brian Johnson*** (s-bjohns67@math.unl.edu), 203 Avery Hall, University of Nebraska-Lincoln, Lincoln, NE 68588-0130. *Graded Cohen-Macaulayness for commutative rings graded by arbitrary abelian groups.* Preliminary report.

We consider a commutative ring R graded by an arbitrary abelian group G, and define the grade of a G-homogeneous ideal I on R in terms of vanishing of Čech cohomology. By defining the dimension in terms of chains of homogeneous prime ideals and supposing R is graded-Noetherian and local, we can define the depth of R and Cohen-Macaulayness. Using these we will discuss a basic theory and sketch a proof of a generalization of the fact that a Noetherian $\mathbb{Z}^d$-graded ring is (graded) Cohen-Macaulay if and only if it is Cohen-Macaulay under the trivial grading. (Received August 23, 2011)

1074-13-251 **Ben J Anderson*** (benjamin.j.anderson@ndsu.edu), NDSU Mathematics Dept #2750, PO Box 6050, Fargo, ND 58108, and **Sean Sather-Wagstaff**. *Nakayama's Lemma for Ext and Ascent for Module Structures.*

Let $\varphi\colon (R,\mathfrak{m},k) \to (S,\mathfrak{m}S,k)$ be a flat local ring homomorphism, and let M be a finitely generated R-module. The following are equivalent:

(1) M has an S-module structure compatible with its R-module structure;

(2) $\mathrm{Ext}^i_R(S,M) = 0$ for $i \geq 1$;

(3) $\mathrm{Ext}^i_R(S,M)$ is finitely generated over R for $i = 1,\dots,\dim_R(M)$;

(4) $\mathrm{Ext}^i_R(S,M)$ is finitely generated over S for $i = 1,\dots,\dim_R(M)$;

(5) $\mathrm{Ext}^i_R(S,M)$ satisfies Nakayama's Lemma over R for $i = 1,\dots,\dim_R(M)$.

This improves upon recent results of Frankild, Sather-Wagstaff, and Wiegand and results of Christensen and Sather-Wagstaff. We will discuss this result and some generalizations. (Received August 22, 2011)

1074-13-262 **K Alan Loper*** (loper.4@osu.edu), Department of mathematics, The Ohio State University, Columbus, OH 43210, and **Carmelo Finocchiaro**. *Ultra-filter closures of collections of valuation domains.* Preliminary report.

For various collections of valuation domains contained in a field we determine subsets which are dense in the ultrafilter topology (equivalent to the patch or constructible topology). (Received August 22, 2011)

1074-13-269 **Ela Celikbas*** (s-ecelikb1@math.unl.edu), Department of Mathematics, University of Nebraska-Lincoln, Lincoln, NE 68588. *Prime ideals in mixed polynomial and power series rings.* Preliminary report.

We discuss the structure of the set of prime ideals in certain two-dimensional domains of mixed polynomial and power series rings. (Received August 22, 2011)

1074-13-286 **Emily E Witt*** (ewitt@umn.edu). *Local cohomology and G-modules.*

Suppose that R is a polynomial ring over a field of characteristic zero with a "very nice" action of a linearly reductive group G. We make use of this action, and apply Lyubeznik's results on D-modules, to study the structure of local cohomology modules $H^i_I(R)$, where I is a certain G-stable ideal. One notable application of this result is the case when $R = k[X]$ is the polynomial ring over an $r \times s$ ($r \leq s$) matrix of indeterminates and I is the ideal generated by its maximal minors. (Received August 23, 2011)

1074-13-288 **Liana M Sega*** (segal@umkc.edu). *On the linearity defect of the residue field.* Preliminary report.

The linearity defect of a finite module M over a local ring is an invariant measuring how far the minimal free resolution of M is from being linear. Over a standard graded k-algebra, a graded module with finite linearity defect has finite Castelnuovo-Mumford regularity as well. It then follows that the linearity defect of k is finite if and only if the algebra is Koszul. We are concerned with the question raised by Herzog on Iyengar of whether a local ring whose residue field has finite linearity defect is necessarily Koszul, in the sense that the associated graded algebra with respect to the maximal ideal is Koszul. We will discuss equivalent formulations and several positive answers in particular cases. (Received August 23, 2011)

1074-13-291 **Augustine B O'Keefe*** (aokeefe@tulane.edu) and **Huy Tài Hà** (tha@tulane.edu). *Cohen-Macaulay Toric Rings Arising from Finite Graphs.* Preliminary report.

Let G be a finite graph and $k[G]$ its associated toric ring. In this talk, we will show how the structure of G affects invariants related to the minimal free resolution of $k[G]$. In particular, using homological methods and the Auslander-Buchsbaum formula, we will determine when $k[G]$ is Cohen-Macaulay. (Received August 23, 2011)

1074-13-303 **Lars Winther Christensen*** (lars.w.christensen@ttu.edu) and **David A Jorgensen**. *A depth formula for Tate Tor-independent modules over Gorenstein rings.* Preliminary report.

Auslander's depth formula for a pair of Tor-independent modules over a regular local ring,

$$\operatorname{depth}(M \otimes_R N) = \operatorname{depth}_R(M) + \operatorname{depth}_R(N) - \operatorname{depth}(R),$$

has been generalized in several directions over a span of four decades. In the talk I will discuss a depth formula that holds for every pair of Tate Tor-independent modules over a Gorenstein local ring. It subsumes previous generalizations of Auslander's formula and yields exact bounds for vanishing of cohomology over certain Gorenstein rings. (Received August 23, 2011)

1074-13-313 **Laura R. Lynch*** (llynch@ccga.edu). *Annihilators of Local Cohomology Modules.*

In many important theorems in the homological theory of commutative local rings, an essential ingredient in the proof is to consider the annihilators of local cohomology modules. We examine these annihilators at various cohomological degrees, in particular at the cohomological dimension and at the height of the grade of the defining ideal. We also investigate the dimension of these annihilators at various degrees and we refine our results by specializing to particular types of rings, for example, Cohen Macaulay rings, unique factorization domains, and rings of small dimension. (Received August 23, 2011)

1074-13-316 **Branden Stone*** (bstone@math.ku.edu), University of Kansas, 405 Snow Hall, 1460 Jayhawk Blvd, Lawrence, KS 66045-7594. *Some relations between countable Cohen-Macaulay representation type and super-streched.*

This work was motivated by a question of Huneke and Leuschke; let R be a complete local Cohen-Macaulay ring of countable Cohen-Macaulay type, and assume that R has an isolated singularity. Is such a ring necessarily of finite Cohen-Macaulay type? We show that R is super-stretched. We also give a partial result to a conjecture attributed to Burban, that is, a Gorenstein ring of countable Cohen-Macaulay type is a hypersurface. In particular, we show this conjecture is true in the one dimensional graded case. (Received August 23, 2011)

1074-13-317 **Kosmas Diveris*** (kjdiveri@syr.edu) and **Marju Purin** (marju.purin@manhattan.edu). *The Generalized Auslander-Reiten Conjecture and Derived Equivalences.* Preliminary report.

We show that the Generalized Auslander-Reiten Conjecture is stable under derived equivalences between Noetherian rings. Recently J. Wei has proved that the Generalized Auslander-Reiten Conjecture is stable under tilting equivalences between Artin algebras. Thus, our result extends Wei's to a wider class of equivalences between a larger class of rings. (Received August 23, 2011)

1074-13-327 **W. Frank Moore*** (moorewf@wfu.edu), PO Box 7388, Winston-Salem, NC 27106, and **Tomoo Matsumura** (matsumura@math.cornell.edu), 291 Daehak-ro, Yuseong-gu, Daejeon, South Korea. *Connected sums of simplicial complexes.*

We define a *weak/strong connected sum* $K_1 \sharp_W K_2$ of simplicial complexes K_1 and K_2 along a common subcomplex W. Our definition is motivated both algebraically and geometrically. Geometrically it is a generalization of the equivariant symplectic connected sum which is the inverse process of Lerman's symplectic cut. Algebraically it is motivated by the connected sum of rings introduced by Ananthnaryan, Avramov, and Moore.

We also study the Tor algebra of the Stanley-Reisner rings of the connected sum. We interpret these algebraic computations in terms of the equivariant cohomolgy of moment angle complexes and in particular describe the symplectic cut of a labeled polytope in terms of moment angle complexes. (Received August 23, 2011)

14 ► Algebraic geometry

1074-14-49 **Nickolas Hein*** (nhein@math.tamu.edu), Nickolas Hein, Department of Mathematics, Texas A&M University, College Station, TX 77843-3368. *Toward a scheme-theoretic Littlewood-Richardson rule.* Preliminary report.

Pieri's rule governs multiplication in Grassmannian cohomology between Schubert classes $[X_\alpha]$ and $[X_\beta]$ indexed by partitions when X_β is special (β has one part). In 1983 David Eisenbud and Joe Harris gave the scheme-structure of

$$\lim_{t\to 0} X_\alpha F \cap X_\beta F(t),$$

where F is the coordinate flag, and $F(t)$ is a *monotonic deformation* of F. Their proof used the Cohen-Macaulay property in an essential way. Later they partially extended this result to a cycle-theoretic Littlewood-Richardson rule giving multiplicities of components but not the scheme structure when X_β is not special. Their methods did not expose whether the limit is Cohen-Macaulay in this case.

I study this monotonic deformation when $F(t)$ is osculating a rational curve, and elucidate the structure of the limit scheme. The method is to use Gröbner bases with an appropriate term order to extract information about the ideal of the limit. $\mathcal{I}(X_\alpha)$ and $\mathcal{I}(X_\beta(t))$ satisfy certian homogeneity properties, and we may exlpoit the structure of bigraded rings. We will see how the Gröbner basis is related to the results of Eisenbud-Harris, and how this may be used to further generalize their work. (Received August 02, 2011)

1074-14-143 **Mike Janssen*** (s-mjansse7@math.unl.edu), Department of Mathematics, University of Nebraska, Lincoln, NE 68588-0130. *Containment Problem for Points on a Reducible Conic in* $\mathbb{P}^2$.

In recent years, much work has been done on the question of comparing symbolic and ordinary powers of an ideal I in a Noetherian ring. In particular, several authors have asked: for which m and r is the symbolic power $I^{(m)}$ contained in the ordinary power I^r? Recent results of Ein, Lazarsfeld, and Smith; Hochster and Huneke; Bocci and Harbourne; and Harbourne and Huneke, address various aspects of this problem. Our results, like those of Bocci and Harbourne, answer the containment question in a geometric setting, where the ideal I is in a polynomial ring over a field. Specifically, we examine the case in which I defines $n+1$ points in $\mathbb{P}^2$, where n points lie on a line L and the remaining point does not lie on L. (Received August 18, 2011)

1074-14-152 **Leslie G. Roberts*** (robertsl@mast.queensu.ca), Department of Mathematics and Statistics, Queen's University, Kingston, Ontario K7L 3N6, Canada, and **Ping Li**. *Projective Monomial Curves in* $\mathbb{P}^3$.

We discuss the ideal generators and Cohen-Macaulay property of projective monomial curves in $\mathbb{P}^3$. (Received August 19, 2011)

1074-14-173 **Hirotachi Abo*** (abo@uidaho.edu), 300 Brink Hall, Department of Mathematics, University of Idaho, Moscow, ID 83844, and **Maria Chiara Brambilla** (brambilla@dipmat.univpm.it), Via Brecce Bianche, Dipartimento di Scienze Matematiche, Università Politecnica delle Marche, 60131 Ancona, Italy. *New examples of defective secant varieties of Segre-Veronese varieties.*

In 1995, Alexander and Hirschowitz finished classifying all the defective secant varieties of Veronese varieties (i.e., the secant varieties of Veronese varieties that do not have the expected dimension). This work completed the Waring-type for polynomials, which had remained unsolved for some time. There are corresponding conjecturally complete list of defective cases for Segre varieties and for Grassmann varieties. Very recently, the defectivity of of Segre-Veronese varieties with two factors was systematically studied and it was suggested that secant varieties of such Segre-Veronese varieties are not defective modulo a fully described list of exceptions. The secant defectivity of more general Segre-Veronese varieties is less well-understood. In this talk, we explore higher secant varieties of Segre-Veronese varieties with three or more factors. The main goal of the talk is to prove the existence of defective secant varieties of three-factor and four-factor Segre-Veronese varieties embedded in a certain multi-degree. These defective secant varieties are previously unknown and are of importance in the classification of defective cases for Segre-Veronese varieties with three or more factors. (Received August 19, 2011)

1074-14-192 **Mats Boij**, Department of Mathematics, KTH, Stockholm, Sweden, **Enrico Carlini**, Dipartimento di Matematica, Politecnico di Torino, Turin, Italy, **Maria Virginia Catalisano**, Dipartimento di Matematica, Universita' di Genova, Genova, Italy, and **Anthony V. Geramita***, Department of Mathematics, Queen's University, Kingston, Ontario , Canada. *Monomials as sums of powers - Part II.*

The talk will focus on Waring's Problem for polynomials, i.e. how to express polynomials as sums of powers of linear polynomials in the "shortest" way, their so-called Waring Decomposition. By a famous theorem of Alexander and Hirschowitz, it is well known what the "generic" situation is, but for specific polynomials it is a largely unresolved problem to find its Waring Decomposition. In this talk I will consider the problem of finding the Waring Decompostion for special classes of polynomials., namely monomials and polynomials not far from being monomials. This is joint work with M. Boij, E. Carlini and M.V. Catalisano. (Received August 21, 2011)

1074-14-238 **Douglas A Torrance*** (torrance@vandals.uidaho.edu) and **Zach Teitler**. *Regularity of $(n-2)$-plane arrangements in $\mathbb{P}^n$ with a complete bipartite incidence graph.* Preliminary report.

Consider an arrangement of linear subspaces of codimension 2 in $\mathbb{P}^n$. We may characterize how each of these subspaces intersect with each other using an incidence graph. Suppose such an arrangement has as its incidence graph the complete bipartite graph $K_{a,b}$, with $a \leq b$. We investigate the Castelnuovo-Mumford regularity of the ideal corresponding to the union of all subspaces in such an arrangement. (Received August 22, 2011)

1074-14-274 **Annika Denkert*** (s-adenker2@math.unl.edu). *Resurgence and related questions for two intersecting lines in $\mathbb{P}^2$.*

Given an ideal I in a polynomial ring over a field, we can define the resurgence of I as the supremum over all ratios m/r such that the m-th symbolic power $I^{(m)}$ is not contained in the r-th ordinary power I^r. We will exhibit some results for the resurgence and related questions in the case that I is the ideal defined by $2n+1$ distinct points in $\mathbb{P}^2$, where n points lie on a line L_1, n points lie on line L_2, and one point is at the intersection of L_1 with L_2. (Received August 23, 2011)

1074-14-290 **Alan Veliz-Cuba***, aveliz-cuba2@unl.edu. *Reverse Engineering of Discrete Models Using Algebraic Geometry.*

Discrete models have been used successfully in modeling biological processes such as gene regulatory networks. When certain regulation mechanisms are unknown it is important to be able to identify the best model with the available data. In this context, reverse engineering of finite dynamical systems from partial information is an important problem. In this talk we will present a framework and algorithm to reverse engineer the possible wiring diagrams of a finite dynamical system from data. The algorithm consists on using algebraic sets to encode all possible wiring diagrams, and choose those that are minimal using the irreducible components. (Received August 23, 2011)

15 ► Linear and multilinear algebra; matrix theory

1074-15-19 **Sivaram K. Narayan*** (sivaram.narayan@cmich.edu), Department of Mathematics, Pearce Hall 218, Central Michigan University, Mount Pleasant, MI 48859. *Bounds for minimum rank problems from superpositions and cut sets.*

The minimum rank of a graph is the smallest possible rank of any real symmetric matrix associated to the given graph. The real (complex) minimum semidefinite rank of a graph is the minimum rank among symmetric (Hermitian) positive semidefinite matrices associated to the given graph. In this talk we present an upper bound on the rank of a graph when the graph is modified from the superposition of two graphs by cancelling some number of edges. We also present a lower bound for minimum semidefinite rank based at a cut set of a graph. When the complement of the cut set is a star forest these lower and upper bounds coincide and we can compute the minimum semidefinite rank in terms of smaller graphs. This result encompasses the case in which the cut set has cardinality two or smaller. Finally we present a similar result when the cut set has cardinality three. (Received June 22, 2011)

1074-15-48 **Colin M Garnett*** (cgarnett@uwyo.edu), 1000 E University Avenue, Laramie, WY 82071. *The Nilpotent-Centralizer method.*

This talk introduces a new criterion for an $n \times n$ sign-pattern (respectively, zero-nonzero pattern), $\mathcal{A}$, to be spectrally arbitrary; that is to have the property that for each monic real polynomial $r(x)$ of degree n there exists a matrix with sign-pattern (respectively, zero-nonzero pattern) $\mathcal{A}$ that has $r(x)$ as its characteristic polynomial. To date, analytic properties of a certain polynomial map associated with $\mathcal{A}$ have been used to to prove that $\mathcal{A}$ is spectrally arbitrary. In this paper, we derive a method that uses the algebraic structure of a certain nilpotent matrix to show that a sign-pattern (respectively zero-nonzero pattern) is spectrally arbitrary. (Received August 02, 2011)

1074-15-64 **Travis A. Peters*** (tpeters@iastate.edu). *Positive Semidefinite Zero Forcing.*

Preliminary report.

The zero forcing number $Z(G)$ is used to study the maximum nullity/minimum rank of the family of symmetric matrices described by a simple, undirected graph G. We study the positive semidefinite zero forcing number $Z_+(G)$ and some of its properties. Given a graph G with some vertices S colored black and the remaining vertices colored white, the positive semidefinite color change rule is: If $W_1, W_2, ..., W_k$ are the sets of vertices of the k components of $G - S$, $w \in W_i$, $u \in S$, and w is the only white neighbor of u in the subgraph of G induced by $W_i \cup S$, then change the color of w to black. The positive semidefinite zero forcing number is the smallest number of vertices needed to be initially colored black so that repeated applications of the positive semidefinite color change rule will result in all vertices being black. The positive semidefinite zero forcing number is a variant of the (standard) zero forcing number, which uses the same definition except with a different color change rule: If u is black and w is the only white neighbor of u, then change the color of w to black. (Received August 19, 2011)

1074-15-102 **Ulrica Wilson*** (uwilson@morehouse.edu), 830 Westview Drive, Atlanta, GA 30314, and **Leslie Hogben** (lhogben@iastate.edu), Ames, IA 50011. *Eventually reducible matrices.*

An eventual property of a matrix $M \in \mathbb{C}^{n\times n}$ is a property that holds for all powers $M^k, k \geq k_0$, for some positive integer k_0. Eventually positive and eventually nonnegative matrices have been studied extensively since their introduction by Friedland in 1978. We studied eventual properties of matrices from a unified perspective and introduce and establish properties of eventually reducible matrices. (Received August 13, 2011)

1074-15-103 **Wayne Barrett***, Department of Mathematics, Brigham Young University, Provo, UT 84602, and **Seth Gibelyou**, **Mark Kempton** (mark.kempton@gmail.com), **Nicole Malloy**, **Curtis Nelson** (curtisgn@gmail.com), **William Sexton** and **John Sinkovic** (johnsinkovic@gmail.com). *The Inverse Eigenvalue Problem for Graphs of Low Minimum Rank.*

Let $G = (V, E)$ be a graph on n vertices, and let $S(G)$ be the set of all real symmetric $n \times n$ matrices such that, for $i \neq j$, $a_{ij} \neq 0 \iff \{i, j\} \in E$. Determining the minimum rank of all matrices in $S(G)$ has been an area of intense study for more than a decade and there are many interesting results. A more difficult and even more interesting problem is the inverse eigenvalue problem:

Given a graph G on n vertices and real numbers $\lambda_1, \lambda_2, \ldots, \lambda_n$, is there a matrix in $S(G)$ with eigenvalues equal to $\lambda_1, \lambda_2, \ldots, \lambda_n$?

Previous results solve the problem for certain trees and for C_n. Another large class of graphs for which it is possible to obtain general results is the class of graphs of low minimum rank. For example, for K_n it is not difficult to show that there exists and an $A \in S(G)$ with any given eigenvalues $\lambda_1, \lambda_2, \ldots, \lambda_n$ provided $\lambda_1 > \lambda_n$. For minimum rank 2 graphs we have a characterization of all possible pairs of nonzero eigenvalues which are attainable for a *rank 2 matrix* in $S(G)$, but not a complete solution in the general case. We will mention some partial results and state some open questions. (Received August 13, 2011)

1074-15-167 **My Huynh*** (mthuynh1@asu.edu), Physical Science A-wing 211, Department of Mathematics, Tempe, AZ 85287-1804. *Propagation Times of Graphs.*

Zero forcing (also called graph infection) on a simple, undirected graph G is based on the color change rule: if each vertex of G is colored either white or black and vertex v is a black vertex with only one white neighbor u then v forces u to become black. A minimum zero forcing set if a set of black vertices of minimum cardinality that can color the entire graph black using the color change rule. The propagation time of a graph G is the minimum amount of time that it takes to force all the vertices of G black using a minimum zero forcing set and performing independent forces simultaneously. The study of propagation times of graphs is related to the study of control quantum systems. Examples that demonstrate various features of the propagation time of a graph are introduced and results on graphs having extreme propagation times are presented. (Received August 19, 2011)

1074-15-170 **Edward D. Hanson*** (hanson@math.wisc.edu), Department of Mathematics, University of Wisconsin, 480 Lincoln Drive, Madison, WI 53706. *A characterization of Leonard pairs using the parameters* $\{a_i\}_{i=0}^d$.

Let V denote a vector space with finite positive dimension. We consider an ordered pair of linear transformations $A : V \to V$ and $A^* : V \to V$ that satisfy (i) and (ii) below:

(1) There exists a basis for V with respect to which the matrix representing A is irreducible tridiagonal and the matrix representing A^* is diagonal.

(2) There exists a basis for V with respect to which the matrix representing A^* is irreducible tridiagonal and the matrix representing A is diagonal.

We call such a pair a *Leonard pair* on V. Arlene Pascasio recently obtained a characterization of the Q-polynomial distance-regular graphs using the intersection numbers a_i. In this talk, we extend her results to a linear algebraic level and obtain a characterization of Leonard pairs. Pascasio's argument appears to rely on the underlying combinatorial assumptions, so we take a different approach that is algebraic in nature. (Received August 19, 2011)

1074-15-176 **Steve Butler*** (butler@iastate.edu), 396 Carver Hall, Dept. of Mathematics, Ames, IA 50010. *Bounding inertia sets of graphs.*

For a graph G, let $\mathcal{S}(G)$ be the collection of all $n \times n$ symmetric real matrices whose nonzero off diagonal entries correspond to the set of edges of G. The inertia set of a graph is the set of all possible pairs (a, b) where a and b are the number of positive and negative eigenvalues respectively of a matrix in $\mathcal{S}(G)$. We will discuss several methods related to computing or bounding inertia sets, including decomposing into smaller parts (called atoms). We also introduce a new variation on zero forcing which can be used to give lower bounds for the inertia of a graph. (Received August 19, 2011)

1074-15-257 **Darren R. Funk-Neubauer*** (darren.funkneubauer@colostate-pueblo.edu), 2200 Bonforte Blvd, Pueblo, CO 81001. *Bidiagonal pairs, the Lie algebra* $\mathfrak{sl}_2$*, and the quantum group* $U_q(\mathfrak{sl}_2)$.

While studying P and Q-polynomial association schemes in the 1990s T. Ito, K. Tanabe, and P. Terwilliger discovered a linear algebraic object called a tridiagonal pair. Since then the theory of tridiagonal pairs has been related to many other areas of mathematics including representation theory, orthogonal polynomials and special functions, partially ordered sets, and statistical mechanics. Roughly speaking, a tridiagonal pair is a pair of diagonalizable linear transformations on a finite dimensional vector space, each of which acts in a tridiagonal fashion on the eigenspaces of the other. Replacing the word "tridiagonal" with "bidiagonal" in the previous sentence defines a similar object called a bidiagonal pair. In this talk I will present a theorem which classifies bidiagonal pairs up to isomorphism. I will also present a number of theorems which establish a close relationship between bidiagonal pairs and representations of the Lie algebra $\mathfrak{sl}_2$ and the quantum group $U_q(\mathfrak{sl}_2)$. (Received August 22, 2011)

1074-15-297 **Richard A Brualdi**, **Kathleen P Kiernan**, **Seth A Meyer*** (smeyer@math.wisc.edu) and **Michael W Schroeder**. *Patterns of Alternating Sign Matrices.*

Recall that an alternating sign matrix (an ASM) is a square matrix with entries 0, +1, or −1 such that the sum of each row and column is +1 and the nonzero entries of each row and column alternate $+1, -1, +1, \ldots, +1$ (if more than one nonzero entry is present). In this talk we discuss the zero-nonzero patterns of $n \times n$ ASMs. We characterize the row (column) sum vectors of these patterns and determine their minimum term rank. In the case of connected ASMs, we find the minimum number of nonzero entries and characterize the case of equality. We will also present some results for symmetric ASMs, in particular, those with only zeros on the main diagonal. These give rise to alternating signed graphs without loops, and we determine the maximum number of edges in such graphs. (Received August 23, 2011)

1074-15-326 **Richard Brualdi** (brualdi@math.wisc.edu), **Louis Deaett*** (ladeaett@quinnipiac.edu), **Dale Olesky** (dolesky@cs.uvic.ca) and **Pauline van den Driessche** (pvdd@math.uvic.ca). *The principal rank characteristic sequence of a real symmetric matrix.*

Given an $n \times n$ real symmetric matrix A we associate to A a sequence $r_0 r_1 \cdots r_n \in \{0,1\}^{n+1}$ defined by

$$r_k = \begin{cases} 1 & \text{if } A \text{ has a principal submatrix of rank } k, \text{ and} \\ 0 & \text{otherwise,} \end{cases}$$

or, equivalently,

$$r_k = \begin{cases} 1 & \text{if } A \text{ has a nonzero principal minor of order } k, \text{ and} \\ 0 & \text{otherwise} \end{cases} \tag{1}$$

for $1 \leq k \leq n$, with $r_0 = 1$ if and only if A has a zero entry on its main diagonal. Denote this sequence by $\mathrm{pr}(A)$.

Now, given an arbitrary sequence of 0s and 1s, is it $\mathrm{pr}(A)$ for any real symmetric matrix A? If so, call the sequence *attainable*. The problem we discuss here is that of characterizing the attainable sequences. (Received August 23, 2011)

1074-15-330 **John Sinkovic*** (johnsinkovic@gmail.com). *The Inverse Inertia Problem for an Outerplanar Graph.* Preliminary report.

Every square real symmetric matrix A has an ordered pair, the partial inertia of A, consisting of the number of positive and negative eigenvalues. A simple graph G can be used to describe the zero/nonzero pattern of the off-diagonal entries of a real symmetric matrix. The inertia set of G is the set of all partial inertias of real symmetric matrices whose off-diagonal zero/nonzero pattern is described by G. Given a simple graph G, what is its inertia set?

In 2009, Barrett, Loewy, and Hall established that the inertia set of a tree T is determined by covers of T consisting of stars and cliques. This idea is extended to all outerplanar graphs by expanding the covering class to include cliques, stars, and cycles. (Received August 23, 2011)

16 ► *Associative rings and algebras*

1074-16-26 **Liping Li*** (lixxx480@math.umn.edu), 504 Vincent Hall 206 Church St. SE., Minneapolis, MN 55455. *Hereditary category algebras of finite EI categories.*

Finite EI categories generalize finite groups and finite posets, and their category algebras generalize group algebras and incidence algebras respectively. Thus the representation theory of finite EI category algebras are of great interests to people studying representations of finite groups, finite posets and quivers.

Given a finite EI category $\mathcal{C}$, it contains finitely many groups and an underlying finite poset. However, the representations of these groups and of the underlying poset cannot determine the representations of $\mathcal{C}$ completely. Understanding the structures of all $(\mathrm{Aut}_{\mathcal{C}}(y), \mathrm{Aut}_{\mathcal{C}}(x))$-bisets $\mathrm{Hom}_{\mathcal{C}}(x,y)$, with $x, y \in \mathrm{Ob}(\mathcal{C})$, is also essential in studying the representations of $\mathcal{C}$.

Under the hypothesis that the automorphism groups of all objects in $\mathcal{C}$ have orders invertible in an algebraically closed filed k, we find a way to construct the ordinary quiver of $k\mathcal{C}$, and give a chracterization of finite EI categories with hereditary category algebras: they are finite free EI categories (in a sense which we define) such that all automorphisms groups of objects have invertible orders in k. (Received July 07, 2011)

1074-16-27 **Yiqiang Li*** (yiqiangl@buffalo.edu). *Tensor product varieties, perverse sheaves and stability conditions.*

A new class of simple perverse sheaves was defined recently by Zheng in categorifying the tensor product of simple modules of a quantized enveloping algebra. In this talk, I will present my recent work on the interaction between certain class of tensor product varieties (in the spirit of Lusztig, Malkin and Nakajima) and this class of simple perverse sheaves. I'll discuss in details the structures of the classes of varieties and perverse sheaves involved. This leads to the equivalence between the localization process using support of complexes and the localization process using singular support of complexes. (Received July 07, 2011)

1074-16-39 **Lei Zhao*** (prescheme@ou.edu), Rm. 423, 601 Elm Ave., Department of Mathematics, University of Oklahoma, Norman, OK 73019. *Finite W-superalgebras for queer Lie superalgebras and higher Sergeev duality.*

We introduce finite W-superalgebras $\mathcal{W}_\chi$ associated to the queer Lie superalgebra $\mathfrak{g} = \mathfrak{q}(N)$ and a nilpotent linear functional $\chi \in \mathfrak{g}_0^*$. We establish a Skryabin type equivalence between the category of $\mathcal{W}_\chi$-modules and a category of certain $\mathfrak{g}$-modules. A higher Sergeev duality is established extending the classical Sergeev duality at level 1 under suitable assumptions. (Received July 22, 2011)

1074-16-123 **Joerg Feldvoss*** (jfeldvoss@jaguar1.usouthal.edu), Department of Mathematics and Statistics, University of South Alabama, Mobile, AL 36688, and **Sarah Witherspoon**, Department of Mathematics, Texas A&M University, College Station, TX 77843. *Support varieties and representation type of self-injective algebras.*

In this talk we will use the theory of support varieties arising from Hochschild cohomology, which was introduced by Snashall and Solberg, and investigated further by Erdmann et al., to obtain an alternative version of a wildness criterion of Bergh and Solberg: If a finite-dimensional self-injective algebra has a module of complexity at least 3 and satisfies some finiteness assumptions on Hochschild cohomology, then the algebra is wild. We will also show how this is directly related to the analogous theory for Hopf algebras that we developed earlier. Finally, we give applications to many different types of algebras: Hecke algebras, reduced universal enveloping algebras, small half-quantum groups, and Nichols (quantum symmetric) algebras. (Received August 16, 2011)

1074-16-279 **Sergio R. López-Permouth** (lopez@ohio.edu), Athens, OH 45701, and **Steve Szabo*** (steve.szabo@eku.edu), Richmond, KY 40475. *A matrix approach to Group Convolutional Codes.*

We generalize to group convolutional codes the matrix-based approach used by Gluesing-Luerssen and Schmale to study cyclic convolutional codes. We then use this approach to extend to this level the results on the existence of dual codes that were originally established by those authors in that context. Our group convolutional codes (and therefore also our cyclic convolutional codes) are part of a wider family than the one usually considered in the literature since we considering them as left ideals of a (sentence-ambient) twisted polynomial ring having, in addition to an automorphism σ, the action of a σ - derivation δ. So, in particular, our results are a generalization of Gluesing-Luerssen and Schmale's even in the context of cyclic convolutional codes. (Received August 23, 2011)

1074-16-320 **Yorck Sommerhäuser*** (sommerh@jaguar1.usouthal.edu), University of South Alabama, Department of Mathematics and Statistics, 411 University Blvd N, Mobile, AL 36688. *Deformed Enveloping Algebras.*

The deformed enveloping algebra of a semisimple Lie algebra is usually defined by generators and relations. Part of these relations describe the commutation relations between the three subalgebras appearing in the triangular decomposition, whereas the remaining part, the so-called deformed Serre relations, describe these subalgebras themselves.

In his book on the subject, G. Lusztig uses a different approach to the deformed Serre relations: He derives them as the consequence of the nondegeneracy of a certain bilinear form. In this way, he obtains a description of two of the three subalgebras appearing in the triangular decomposition that is not based on generators and relations; the third subalgebra is just the group ring of an abelian group.

However, it is possible to give a construction of deformed enveloping algebras without any reference to relations. For this, one has to note that, although the subalgebras described by the deformed Serre relations are not Hopf subalgebras, they are Yetter-Drinfel'd Hopf algebras over the above-mentioned group ring, and there is a universal construction that yields the deformed enveloping algebra when applied to this Yetter-Drinfel'd Hopf algebra. In the talk, we explain the details of this construction. (Received August 23, 2011)

17 ► Nonassociative rings and algebras

1074-17-55 **Daniel K. Nakano*** (nakano@math.uga.edu), Department of Mathematics, University of Georgia, Athens, GA 30602. *Cohomological detection for Lie superalgebras with applications to support varieties.*

Boe, Kujawa and the speaker investigated the relative cohomology for classical Lie superalgebras and constructed support varieties for modules over these algebras. The striking feature of these support varieties was that for irreducible representations over basic classical Lie superalgebras, the dimensions of the support varieties recover the combinatorial notions of defect and atypicality defined by Kac and Wakimoto.

In this talk we use invariant theory to develop the notion of cohomological detection for Type I classical Lie superalgebras. In particular we show that the cohomology with coefficients in an arbitrary module can be detected on smaller subalgebras. These results are used later to affirmatively answer questions, which were originally posed by Bagci, Boe, Kujawa and the speaker, about realizing support varieties for Lie superalgebras via rank varieties constructed for the smaller detecting subalgebras.

This is joint work with Gus Lehrer and Ruibin Zhang. (Received August 04, 2011)

1074-17-93 **Christopher M. Drupieski*** (cdrup@math.uga.edu), Department of Mathematics, University of Georgia, Boyd Graduate Studies Research Center, Athens, GA 30602-7403. *Some quantum analogues of results from Lie algebra cohomology.*

Let $\mathfrak{g}$ be a complex semisimple Lie algebra. Many classical results on the (Chevalley-Eilenberg) Lie algebra cohomology of $\mathfrak{g}$ rely on the explicit projective resolution of the trivial module afforded by the Koszul complex. For example, the resolution plays an important role in Koszul's algebraic proof that the cohomology ring $H^*(\mathfrak{g}, \mathbb{C})$ of $\mathfrak{g}$ is an exterior algebra over a subspace with odd gradation. The resolution also appears in Chevalley and Eilenberg's proof that the cohomology of $\mathfrak{g}$ with coefficients in a nontrivial irreducible module is always zero. In this talk we will discuss generalizations of these results to the quantized enveloping algebra $U_q(\mathfrak{g})$ associated to $\mathfrak{g}$. Though there is no (known) analgoue of the Koszul complex for quantized enveloping algebras, we can still obtain explicit cohomology calculations through a (sometimes indirect) comparison to classical Lie algebra cohomology. (Received August 12, 2011)

1074-17-139 **Dimitar Grantcharov*** (grandim@uta.edu), Department of Mathematics, University of Texas at Arlington, Arlington, TX 76019, and **Ji Hye Jung**, **Seok-Jin Kang**, **Masaki Kashiwara** and **Myungho Kim**. *Crystal bases for the quantum queer superalgebra and semistandard decomposition tableaux.*

The Lie superalgebra $\mathfrak{q}(n)$ is the second super-analogue of the general Lie algebra $\mathfrak{gl}(n)$. Due to its complicated structure, $\mathfrak{q}(n)$ is usually called "the queer superalgebra". In this talk we will discuss how to develop crystal basis theory of the so called tensor representations of the quantum queer superalgebra $U_q(\mathfrak{q}(n))$. An explicit combinatorial realization of the crystal corresponding to an irreducible tensor $U_q(\mathfrak{q}(n))$–module in terms of semistandard decomposition tableaux will be provided. (Received August 18, 2011)

1074-17-246 **Garrett Johnson*** (gwjohns3@ncsu.edu) and **Chris Nowlin**. *The FRT-Construction via Quantum Affine Algebras and Smash Products.*

For every element w in the Weyl group of a simple Lie algebra $\mathfrak{g}$, De Concini, Kac, and Procesi defined a subalgebra $\mathcal{U}_q^w$ of the quantized universal enveloping algebra $\mathcal{U}_q(\mathfrak{g})$. The algebra $\mathcal{U}_q^w$ is a deformation of the universal enveloping algebra $\mathcal{U}(\mathfrak{n}_+ \cap w.\mathfrak{n}_-)$. We construct smash products of certain finite-type De Concini-Kac-Procesi algebras to obtain ones of affine type; we have analogous constructions in types A_n and D_n. We show that the multiplication in the affine type De Concini-Kac-Procesi algebras arising from this smash product construction can be twisted by a cocycle to produce certain subalgebras related to the corresponding Faddeev-Reshetikhin-Takhtajan bialgebras. (Received August 22, 2011)

1074-17-266 **Vitaly Tarasov*** (vt@math.iupui.edu). *Capelli-type identities and duality of Bethe algebras.*

In 2006 E. Mukhin, A. Varchenko and myself obtained a generalization of the Capelli identity describing the duality of certain commutative subalgebras (Bethe subalgebras) of the universal enveloping algebras $U(\mathfrak{gl}_m[t])$ and $U(\mathfrak{gl}_n[t])$ of current algebras. The claim holds in the framework of the $(\mathfrak{gl}_m, \mathfrak{gl}_n)$ duality — the Bethe subalgebras have the same image acting on the $\mathfrak{gl}_m \oplus \mathfrak{gl}_n$-module of polynomials on $m \times n$ matrices. The identity itself is an equality of determinants of three matrices whose entries are differential operators. It is a

noncommutative version of the formula for the determinant of a block matrix: $\det \begin{pmatrix} A & B \\ C & D \end{pmatrix} = \det(A)\,\det(D - CA^{-1}B)$.

I will discuss a farther generalization of that Capelli-type identity with differential operators replaced by difference operators. It describes the duality of Bethe subalgebras of the quantum loop algebras $U_q(\widetilde{\mathfrak{gl}_m})$ and $U_q(\widetilde{\mathfrak{gl}_n})$. Degenerating as $q \to 1$, one gets a new Capelli-type identity for matrices whose entries are differential operators. It describes the duality of Bethe subalgebras of $U(\mathfrak{gl}_m[t])$ and the Yangian $Y(\mathfrak{gl}_n)$. (Received August 22, 2011)

1074-17-309 **Irfan Bagci**, **Konstantina Christodoulopoulou** and **Emilie Wiesner*** (ewiesner@ithaca.edu). *Whittaker categories for Lie superalgebras.* Preliminary report.

Whittaker modules were first studied in depth by Kostant. Since then, a number of others have further developed the idea of Whittaker modules for Lie algebras. In this talk, I'll discuss how we have adapted these ideas to the setting of Lie superalgebras. (Received August 23, 2011)

20 ► Group theory and generalizations

1074-20-5 **Christopher M. Drupieski**, **Daniel K. Nakano** and **Nham V. Ngo*** (nham@uga.edu), Department of Mathematics, University of Georgia, Athens, GA 30602. *Cohomology for infinitesimal unipotent algebraic and quantum groups.*

In this paper we study the structure of cohomology spaces for the Frobenius kernels of unipotent and parabolic algebraic group schemes and of their quantum analogs. Given a simple algebraic group G, a parabolic subgroup P_J, and its unipotent radical U_J, we determine the ring structure of the cohomology ring $\mathrm{H}^\bullet((U_J)_1, k)$. We also obtain new results on computing $\mathrm{H}^\bullet((P_J)_1, L(\lambda))$ as an L_J-module where $L(\lambda)$ is a simple G-module with high weight λ in the closure of the bottom p-alcove. Finally, we provide generalizations of all our results to the quantum situation. (Received June 30, 2011)

1074-20-6 **Paul-Hermann Zieschang*** (zieschang@utb.edu), Department of Mathematics, UTB, 80 Fort Brown, Brownsville, TX 78520. *Hypergroups.*

Let S be a set, and let μ be a map from $S \times S$ to the power set of S. For any two elements p and q of S, we write pq instead of $\mu(p, q)$ and assume that pq is not empty.

For any two non-empty subsets P and Q of S, we define PQ to be the union of the sets pq with $p \in P$ and $q \in Q$. If one of the factors in a complex product consists of a single element s, we write s instead of $\{s\}$ in that product.

Following (and generalizing) Frédéric Marty's terminology we call S a hypergroup (with respect to μ) if the following three conditions hold.

(H1) For any three elements p, q, and r in S, we have $p(qr) = (pq)r$.

(H2) The set S possesses an element e such that $se = \{s\}$ for each element s in S.

(H3) For each element s in S, there exists an element s^* in S such that $p \in rq^*$ and $q \in p^*r$ for any three elements p, q, and r in S satisfying $r \in pq$.

It is easy to see that hypergroups generalize association schemes. In my talk, I will provide results on hypergroups which may suggest research directions within the theory of hypergroups.

Reference: Hypergroups. Preprint (Max-Planck-Institut für Mathematik, Bonn, Preprint Series 2010 (97)) (Received April 09, 2011)

1074-20-22 **Miodrag Cristian Iovanov*** (yovanov@gmail.com), 3620 S Vermont St KAP108, Los Angeles, CA 90089, and **Susan Montgomery**, Los Angeles, CA. *Frobenius-Schur indicators of quantum groups and symmetric tensor categories.* Preliminary report.

In the classical representation theory of groups, the (2nd) Frobenius-Schur indicator provides the answer to the question if a complex representation is real or not, or more generally, whether a representation over the reals is real, complex or quaternionic. The generalized (n-th) F-S indicators also provide interesting invariants; they were extended to Hopf algebras by Montgomery and Linchenko, and then to tensor categories by Mason, Ng, Schauenburg. These indicators turned out to be powerful invariants: they can distinguish nonequivalent representation theories with the same character ring (such are examples of 8 dimensional tensor categories, or non-abelian 8-groups). While these invariants are not integers in general, all known examples where the category is symmetric have integer F-S indicators, and it is conjectured that this should be true in such a general setting. We give new results on the indicators of representations of Drinfeld doubles of groups, some equivalent number

theoretical conditions for the integrality of these indicators, and using the theoretical results as well as careful computer algebra, we find many interesting counterexamples to the above mentioned conjecture. This includes work in progress and results of the author and S.Montgomery, R.Ng, G.Mason. (Received June 28, 2011)

1074-20-38 **Mark Sapir*** (m.sapir@vanderbilt.edu), SC 1326, Department of Mathematics, Vanderbilt University, Nashville, TN 37221-4629. *Aspherical groups and manifolds with extreme properties.*

I prove that every finitely generated group with recursive aspherical presentation complex embeds inta a group with finite aspherical presentation complex. Using Gromov's random groups and Davis' trick, this implies existence of aspherical manifolds whose fundamental groups do not coarsely embed into Hilbert spaces, do not satisfy property A, have infinite asymptotic dimension and do not satisfy the Baum-Connes conjecture with coefficients. (Received July 21, 2011)

1074-20-61 **Stuart W Margolis**, **Franco Saliola** and **Benjamin Steinberg***, Department of Mathematics, City College of New York, NAC 8/133 Convent Ave at 138th Street, New York, NY 10031. *Poset cohomology, Leray numbers and the global dimension of left regular bands.*

A series of papers by Bidigare, Hanlon and Rockmore, K. Brown and Diaconis, Brown, Björner, Athanasiadis and Diaconis, and Chung and Graham have shown that many combinatorial objects admit the structure of a left regular band semigroup (LRB). This structure allows one to apply the character theory of LRBs to analyze random walks on the corresponding combinatorial objects. Examples of such combinatorial structures include real and complex hyperplane arrangements, oriented matroids, matroids and interval greedoids. Random walks that can be analyzed in this fashion include the Tsetlin library and riffle shuffles.

Saliola initiated in his thesis under Brown an in-depth study of the representation theory of LRBs. Our aim is to compute the global dimension of the algebra of an LRB. We are able to interpret the global dimension of the algebra of an LRB B in terms of the maximum non-vanishing dimension of the cohomology of certain subposets of B. Thus the Leray number of the order complex of B is an upper bound on the global dimension, which is sometimes tight. Conversely, given any flag complex X, the corresponding right-angled Artin LRB has global dimension precisely the Leray number of X . (Received August 07, 2011)

1074-20-63 **Ilya Kapovich*** (kapovich@math.uiuc.edu), UIUC Department of Mathematics, 1409 West Green Street, Urbana, IL 61801, and **Mathieu Carette**, **Stefano Francaviglia** and **Armando Martino**. *Spectral rigidity of automorphic orbits in free groups.*

It is well-known that a point $T \in cv_N$ in the (unprojectivized) Culler-Vogtmann Outer space cv_N is uniquely determined by its *translation length function* $||.||_T : F_N \to \mathbb{R}$. A subset S of a free group F_N is called *spectrally rigid* if, whenever $T, T' \in cv_N$ are such that $||g||_T = ||g||_{T'}$ for every $g \in S$ then $T = T'$ in cv_N. By contrast to the similar questions for the Teichmüller space, it is known that for $N \geq 2$ there does not exist a finite spectrally rigid subset of F_N.

In this paper we prove that for $N \geq 3$ if $H \leq Aut(F_N)$ is a subgroup that projects to an infinite normal subgroup in $Out(F_N)$ then the H-orbit of an arbitrary nontrivial element $g \in F_N$ is spectrally rigid. We also establish a similar statement for $F_2 = F(a, b)$, provided that $g \in F_2$ is not conjugate to a power of $[a, b]$. (Received August 08, 2011)

1074-20-73 **Moon Duchin*** (Moon.Duchin@tufts.edu) and **Christopher Mooney**. *Fine asymptotic geometry in the Heisenberg group.*

We develop technology for studying word metrics on the integer Heisenberg group that is fine enough to detect properties that depend on the choice of generating set. (Received August 09, 2011)

1074-20-85 **Said N. Sidki*** (ssidki@gmail.com), Departamento de Matematica, Universidade de Brasilia, shin ql03 conj08 casa 10, Brasilia, DF 70910-900, Brazil. *On n-ary adding machines and solvable groups.*

In a joint work with Josimar de Silva Rocha, we describe under a variety of conditions abelian subgroups of the automorphism group A of the regular n-ary tree T which are normalized by the n-ary adding machine t=(e,...,e,t)s where s is the n-cycle (0,1,...,n-1). As an application, for n a prime number, and for n = 4 we prove that every finitely generated soluble subgroup of A containing t is an extension of a torsion-free metabelian group by a finite group. (Received August 11, 2011)

1074-20-105 **Alexei Miasnikov** and **Zoran Sunic*** (sunic@math.tamu.edu). *Cayley automatic groups are not necessarily Cayley biautomatic.* Preliminary report.

We show that there exist Cayley automatic groups that are not Cayley biautomatic. In addition, we show that there are Cayley automatic groups with undecidable Conjugacy Problem and that the Isomorphism Problem is undecidable in the clas of Cayley automatic groups. (Received August 14, 2011)

1074-20-107 **Delaram Kahrobaei*** (dkahrobaei@gc.cuny.edu), PhD Program in Computer Science, CUNY Graduate Center, 365 Fifth Avenue, New York, NY 10016. *A decade of using non-commutative groups in cryptography.* Preliminary report.

In this talk I will give a quick survey of development of new cryptosystems using non-commutative groups, their weaknesses, strengths as well as new directions. I will also describe a couple of my new results. (Received August 14, 2011)

1074-20-120 **Vesna Kilibarda*** (vkilibar@iun.edu), Indiana University Northwest, Department of Mathematics, 3400 Broadway, Gary, IN 46408, and **Simon Craik**, **Robert D. Gray**, **Victor Maltcev**, **James D. Mitchell** and **Nik Ruskuc**. *Ends of Semigroups.*

In this paper we study two definitions of ends for semigroups. We examine the cancellative semigroups analogue of the theorem about $1, 2, \infty$ number of ends in groups and prove it for the one of the definitions we propose. We also study how number of ends changes under certain finite semigroup indices. In examples we demonstrate several techniques for calculating the number of ends of semigroups. (Received August 16, 2011)

1074-20-127 **Hao Liang*** (hliang8@uic.edu). *Centralizers of finite subgroups of the mapping class group and almost fixed points in the curve complex.*

Let S be an orientable surface of finite type, MCG(S) the mapping class group of S, C(S) the curve complex of S, and H a finite subgroup of MCG(S). By δ-hyperbolicity of C(S), there exists a H-orbit in C(S) of diameter at most 8δ. We prove that there exists a constant K depending only on S so that if the diameter of the set of points with small H-orbits is greater than K then the centralizer of H in MCG(S) is infinite. I will start by explaining the proof of the analogous statement for hyperbolic groups, and if time permits I will explain the extra ingredients needed for the case of mapping class groups. (Received August 16, 2011)

1074-20-136 **John Donnelly***, 8600 University Boulevard, Evansville, IN 47712. *Weakly-Ruinous and Strongly-Thin Subsets of Richard Thompson's Group F.*

Richard Thompson's group F is the group given by the presentation

$$\langle x_0, x_1, x_2, \ldots \mid x_n x_m = x_m x_{n+1} \text{ for } n > m \rangle .$$

The monoid defined by this presentation is denoted by P and is called the *positive monoid* of the group F. The elements of the monoid P can be represented geometrically using binary trees and binary forests. Using this representation, one can define the notions of *weakly-ruinous set* and *strongly-thin set*. It is a long standing open question as to whether or not the group F is amenable. It has been shown that the group F is nonamenable if and only if there exists a weakly-ruinous set. In this talk we state some sets that must be weakly-ruinous if F is nonamenable. We then give some conditions that a set must satisfy to be strongly-thin. (Received August 17, 2011)

1074-20-141 **Lucas Sabalka*** (sabalka@math.binghamton.edu) and **Dmytro Savchuk**. *On restricting free factors in relatively free groups.*

Let G be a free, free nilpotent, or free metabelian group, and let $A = \{a_1, ..., a_n\}$ be a basis for G. We will show that if S is a subset of a basis for G which may be expressed without the element a_n then, with small restrictions on the size of S, the set S is a subset of a basis for the relatively free group on $A - \{a_n\}$. (Received August 23, 2011)

1074-20-160 **Harvey I. Blau*** (blau@math.niu.edu), Department of Mathematical Sciences, Northern Illinois University, DeKalb, IL 60115. *Fusion rings with few degrees.*

Fusion rings whose degree set consists of 1 and a fixed prime are characterized. The conclusion involves standard integral table algebras with a similar degree set. In certain cases, the latter algebra's arising from an association scheme is a necessary condition for the fusion ring to be the Grothendieck ring of a fusion category. A well known theorem of Isaacs and Passman on finite groups whose irreducible character degrees are 1 and a prime is a corollary of the main result. (Received August 19, 2011)

1074-20-177 **Sonja Mitchell*** (smitchell@math.ucsb.edu). *A* Type B *version of Thompson's Group F.* We consider Thompson's Group F as generated by "flip-renormalize" actions on the Farey Tesselation of the hyperbolic plane. Using this approach, we define a *Type B* version of the group, which we call F_B. A construction of F_B and preliminary results will be discussed. (Received August 20, 2011)

1074-20-185 **Robert H Gilman*** (rgilman@stevens.edu). *Complexity of Group Theoretic Algorithms.* Preliminary report.

Computational procedures for finitely presented groups have been studied for at least one hundred years, yet there are few results on their efficacy. We will discuss some of these procedures and the extent to which techniques from the theory of computational complexity apply to them. (Received August 20, 2011)

1074-20-189 **Owen Baker*** (obaker@math.cornell.edu), Dept. of Mathematics and Statistics, Hamilton Hall, McMaster University, 1280 Main Street West, Hamilton, ON L8S 4K1, Canada. *Towards the Second Integral Homology of IA_3.*

The outer automorphism group $Out(F_n)$ of a rank n free group acts on Culler-Vogtmann Outer space X_n with finite point stabilizers. Let IA_n denote the kernel of the natural homomorphism $Out(F_n) \to GL_n(\mathbb{Z})$. Since IA_n is torsion-free and X_n is contractible, the quotient X_n/IA_n is an Eilenberg-MacLane space (a $K(IA_n, 1)$). In this talk, I will define a 2-dimensional subspace $\widetilde{A}$ of $K = X_3/IA_3$ such that $H_i(\widetilde{A}; \mathbb{Z}) \to H_i(IA_3; \mathbb{Z})$ is surjective for all i. I will show that the kernel of $H_2(\widetilde{A}; \mathbb{Z}) \to H_2(IA_3; \mathbb{Z})$ is generated by two elements as a $GL_3(\mathbb{Z})$-module. This reduces the open question of whether the second integral homology of IA_3 is finitely generated as a $GL_3(\mathbb{Z})$-module to the same question for the 2-complex $\widetilde{A}$. (Received August 20, 2011)

1074-20-197 **Kenneth W Johnson*** (kwj1@psu.edu). 2-*S-rings of groups and generalizations.* Preliminary report.

The S-ring arising from the orbits of an action of a permutation group M on a finite group G is familiar, the most basic example being the S-ring of conjugacy classes of a group which gave rise to Frobenius' first definition of group character theory. The orbits of $G \times \mathcal{S}_k$ acting on k-tuples of elements of G, with an element $g \in G$ acting by simultaneous conjugation and an element σ in the symmetric group $\mathcal{S}_k$ acting by

$$\sigma(g_1, g_2, ..., g_k) = (g_{\sigma(1)}, g_{\sigma(2)}, ..., g_{\sigma(k)}),$$

arise naturally in the theory of higher characters.

For the case $k = 2$ Humphries and his students have studied the 2-*S-ring* of a group. Explicitly this consists of the subalgebra of $\mathbb{Z}(G \times G)$ which is generated by the element sums of the orbits described above. It is not necessarily commutative. They have proved that if groups G_1 and G_2 have the same irreducible 2-characters and isomorphic 2-S-rings then G_1 and G_2 have the same derived length. I will discuss how there are more general coherent configurations which arise, and also conditions for which the symmetrization of such coherent configurations are association schemes. (Received August 21, 2011)

1074-20-206 **Brian J. Parshall*** (bjp8w@virginia.edu). *Some filtration results for Weyl modules.* Preliminary report.

This talk will discuss recent results concerning some important filtrations of Weyl modules for a semisimple algebraic group G over a field of positive characteristic. The methods involve new techniques involving Kac-Moody Lie algebras, quantum groups, and integral representation theory. This is joint work with Leonard Scott. (Received August 21, 2011)

1074-20-220 **Alexander J Hulpke***, Department of Mathematics, Colorado State University, Fort Collins, CO 80523-1874. *Using Composition Trees for calculations with groups.*

The concept of a composition tree evolved from the matrix group recognition project as a generalization of the concept of a stabilizer chain. This concept adapts to many classes of finite groups and to quotients of finitely presented groups. I will show how to use a composition tree for higher level calculations in the group, such as subgroup normalizer. (Received August 22, 2011)

1074-20-223 **Inna Bumagin*** (bumagin@math.carleton.ca), School of Mathematics and Statistics, Carleton University, 1125 Colonel By Drive, Ottawa, ON K1S5B6, Canada. $\mathbb{Z}^n$*-free groups are CAT(0).*

Alibegovic and Bestvina proved that limit groups are CAT(0). We generalize their theorem and show that every finitely generated group equipped with a free Lyndon $\mathbb{Z}^n$ length function is CAT(0).

This is joint work with O.Kharlampovich. (Received August 22, 2011)

1074-20-225 **Jonathan D.H. Smith*** (jdhsmith@iastate.edu), Department of Mathematics, 396 Carver Hall, Iowa State University, Ames, IA 50011-2064. *Sylow theory for quasigroups.* Preliminary report.

Classical Sylow theory for groups has recently been extended in two directions: to association schemes by Hirasaka, Muzychuk and Zieschang, and to Moufang loops by S. Gagola III, Grishkov and Zavaritsine. In this talk, the possibilities for extending Sylow theory to general quasigroups (and left quasigroups) will be discussed, in connection with the permutation representation theory for these structures. (Received August 22, 2011)

1074-20-226 **Cornelius Pillen*** (pillen@jaguar1.usouthal.edu), Department of Mathematics and Statistics, University of South Alabama, Mobile, AL 36688. *Calculating finite group cohomology with Kostant partition functions.* Preliminary report.

A recent theorem by Chris Bendel, Dan Nakano and the presenter shows that in the defining characteristic the dimensions of the cohomology spaces of finite groups of Lie type can be bound above via a formula involving Kostant partition functions. In this talk we will show how this formula can be used to find the lowest positive degree in which the groups $\mathrm{Spin}(2l+1, p^n)$ (type B) have non-zero cohomology. (Received August 22, 2011)

1074-20-232 **Hanna Bennett*** (hbennett@umich.edu). *On the linearity of automorphism groups of right-angled Artin groups.* Preliminary report.

Right-angled Artin groups (RAAGs) are groups with a presentation in which the only relators are commutators between generators; these can be thought of as interpolating between free groups and free abelian groups. It is a result of Formanek and Procesi that the automorphism group of a free group with at least three generators is not linear. This leads to the natural question: which RAAGs have linear automorphism groups? We will give a partial answer to this question. (Received August 22, 2011)

1074-20-264 **David McCune*** (mccune.dave@gmail.com). *A class of metabelian automaton groups.*

Recently, many papers have been written which classify the groups that arise from a given finite class of invertible automata (see Classification of groups generated by 3-state automata over a 2-letter alphabet by Bondarenko et al., for example). In this talk, we classify the metabelian groups that arise from a finite class of automata. It was previously known that the (metabelian) lamplighter group is a member of this class; this talk investigates what other "lamplighter-like" groups arise in this class of groups. (Received August 22, 2011)

1074-20-296 **Dmytro M Savchuk*** (dmytro.savchuk@gmail.com), Department of Mathematical Sciences, Binghamton University, Binghamton, NY 13902. *Schreier graphs and Schreier dynamical system of the action of Thompson's group F on the Cantor set.*

We construct Schreier graphs of the actions of Thompson's group F on the orbits of all points of the Cantor set with respect to the standard generating set $\{x_0, x_1\}$, classify them up to isomorphism, and study the corresponding Schreier dynamical system.

Schreier dynamical systems were studied in the context of ergodic theory by Zimmer, Vershik and Grigorchuk. Sometimes it is possible to show that given an action of a group on a set, the Schreier dynamical system constructed from just one orbit, can recover the original action of the group on the whole set. We show that this is exactly the case for the action of F on the Cantor set.

Finally, we show that all constructed Schreier graphs are amenable. (Received August 23, 2011)

1074-20-308 **Alexei Miasnikov***, Department of Mathematics, Stevens Institute, Hoboken, NJ 07030. *Solving equations in the Grigorchuk group G.*

I will discuss decidability of Diophantine Problem in the Grigorchuk group G. First, I will touch one the classical algorithmic problems in G (The Word, Conjugacy, and Membership Problems), and then move to decidability of arbitrary quadratic equations in G. There are very interesting unusual effects in G that make the decision algorithms possible. The talk is based on joint results with Igor Lysenok and Sasha Ushakov. (Received August 23, 2011)

22 ► Topological groups, Lie groups

1074-22-164 **Evgeny Mukhin***, 402, N. Blackford St, LD270, Department of Mathematical Sciences, IUPUI, Indianapolis, IN 46202. *Representations of quantum affine groups.*

We will survey the recent progress in the theory of finite-dimensional representations of quantum affine groups. We will also discuss connections to various subjects. This talk is based on a joint work with Charles Young. (Received August 19, 2011)

30 ► Functions of a complex variable

1074-30-23 **Valentin V Andreev** and **Timothy H McNicholl*** (timothy.h.mcnicholl@gmail.com), Department of Mathematics, Lamar University, Beaumont, TX 77710. *An potential-theoretic construction of the Schwarz-Christoffel map for multiply connected domains.*

We explicitly construct the Schwarz-Christoffel map from a (bounded or unbounded) finitely connected Jordan domain to a (bounded or unbounded) finitely connected polygonal domain. The map is derived in terms of Green's function and the harmonic measure functions of the Jordan domain which need not be a canonical multiply connected domain. We discuss possibilities for computation and formulas in terms of the elementary functions.

References

1. V.V. Andreev and T.H. McNicholl, *A potential-theoretic construction of the Schwarz-Christoffel map for finitely connected domains*, To appear in Complex Variables and Elliptic Equations.

(Received June 28, 2011)

34 ► Ordinary differential equations

1074-34-25 **Douglas R Anderson*** (andersod@cord.edu), 901 8th Street S., Department of Mathematics, Moorhead, MN 56562. *Hyers-Ulam stability of second-order linear dynamic equations on time scales.* Preliminary report.

Using integrating factors we establish the stability of second-order linear dynamic equations on time scales in the sense of Hyers and Ulam. To wit, if an approximate solution of the second-order linear equation exists, then there exists an exact solution to the dynamic equation that is close to the approximate one. (Received June 29, 2011)

1074-34-28 **Ali Abd Albaghdadi*** (alaasalam90@yahoo.com), Iraq-Baghdad, Kahira, District311,St.61, House No.12, Iraq. *Analytical solution of Bessel differential equation.*

The current solutions of seccond order differential equations with variable coefficients are either by use of series or numerical analysis,which both are rather difficult and give an approximate results. In this paper we apply a certain method to solve Bessel equation as an example of solutions for some important second order differential equations analytically. The final solution is dependent upon the integrals of fractional powers of the independent variable multiplied by sine or cosine functions. The advantage of this method is to give a simplified form of solution which can be studied easily,in spite of the difficulty of the evaluation of integrals. moreover, the solution of nonhomogeneous second order equations is also possiple, such as Lommel, Anger and Struve equations. By this method we can put a general solution of Bessel,modified bessel,spherical Bessel,modified spherical Bessel, Lommel,Anger and Struve equations, generally for every equations of the same form. (Received July 07, 2011)

1074-34-72 **Qingkai Kong*** (kong@math.niu.edu) and **Qi-Ru Wang** (mcswqr@mail.sysu.edu.cn). *Using time scales to study multi-interval Sturm-Liouville problems with interface conditions.*

We consider a Sturm-Liouville problem defined on multiple intervals with interface conditions. The existence of a sequence of eigenvalues is established and the zero counts of associated eigenfunctions are determined. Moreover, we reveal the continuous and discontinuous nature of the eigenvalues on the boundary condition. The approach in this paper is different from those in the literature: We transfer the Sturm-Liouville problem with interface conditions to a Sturm-Liouville problem on a time scale without interface conditions and then apply the Sturm-Liouville theory for equations on time scales. In this way, we are able to investigate the problem in a global view. Consequently, our results cover the cases when the potential function in the equation is not strictly greater than zero and when the domain consists of an infinite number of intervals. (Received August 09, 2011)

1074-34-94 **Raziye Mert*** (raziyemert@cankaya.edu.tr), Cankaya University, Department of Mathematics, and Computer Science, 06530 Ankara, Ankara, Turkey, and **Ağacık Zafer**. *Oscillation of Even Order Nonlinear Delay Dynamic Equations on Time Scales.*

This is a joint work with Ağacık Zafer. One of the important methods for studying the oscillation of higher order differential equations is to make a comparison with second order differential equations. The method involves using Taylor series expansion of solutions. In this talk we show how such a method can be used for a class of even order delay dynamic equations on time scales via comparison with second order dynamic inequalities.

In particular, it is shown that nonexistence of an eventually positive solution of a certain second order delay dynamic inequality is suffcient for oscillation of even order dynamic equations on time scales. The arguments are based on Taylor polynomials on time scales. (Received August 12, 2011)

1074-34-104 **Christopher S. Goodrich*** (s-cgoodri4@math.unl.edu), University of Nebraska-Lincoln, 203 Avery Hall, Lincoln, NE 68588. *Green's Functions for Discrete and Continuous Fractional BVPs.*

In this presentation we will talk about the Green's function and its properties for two boundary value problems in the fractional calculus. We will first look at the Green's function for the discrete right-focal BVP of fractional order $1 < \nu \leq 2$. We will then look at the Green's function for a continuous right-focal BVP of fractional order $\nu > 3$. We will highlight certain of the differences and similarities between these Green's functions and those that arise in the integer-order setting. (Received August 13, 2011)

1074-34-122 **Qingkai Kong** (kong@math.niu.edu), Department of Mathematical Sciences, Northern Illinois University, DeKalb, IL 60115, and **Min Wang*** (min-wang@utc.edu), Department of Mathematics, University of Tennessee at Chattanooga, Chattanooga, TN 37403. *Existence of positive solutions of 2nth order system periodic boundary value problems via eigenvalue approach.*

We study an even order system boundary value problem with periodic boundary conditions. By establishing the existence of a positive eigenvalue of an associated linear system Sturm-Liouville problem, we obtain new conditions for the boundary value problem to have a positive solution. Our major tools are the Krein-Rutman theorem for linear spectra and the fixed point index theory for compact operators. (Received August 16, 2011)

1074-34-180 **Elvan Akin-Bohner** and **Martin Bohner*** (bohner@mst.edu), Missouri S&T, Department of Mathematics and Statistics, 400 West 12th Street, Rolla, MO 65409-0020, and **Thomas Matthews**. *Time Scales Ostrowski and Grüss Type Inequalities involving Three Functions.*

We present time scales versions of Ostrowski and Grüss type inequalities containing three functions. We assume that the second derivatives of these functions are bounded. Our results are new also for the discrete case. (Received August 20, 2011)

1074-34-243 **Kevin A Ahrendt*** (kahrendt@gmail.com), 1010 D street, Apartment 212, Lincoln, NE 68502, and **Mike Holm**, **Lucas Castle** and **Kathryn Yochman**. *Nabla Laplace Transforms and Fractional Calculus.* Preliminary report.

We will define and present several properties of the nabla Laplace transform. We use these results to help us find a variation of constants formula for a nabla fraction initial value problem. To do this we will define the appropriate Mittag-Leffler function. Also composition rules for the nabla fractional calculus will be given. (Received August 22, 2011)

1074-34-245 **Eric R Kaufmann*** (erkaufmann@ualr.edu), University of Arkansas at Little Rock, Department of Mathematics nd Statistics, 2801 S. University Ave, Little Rock, AR 72204. *Periodic solutions of a second-order differential equation with p-Laplacian operator.* Preliminary report.

We consider the existence of solutions to the second-order nonlinear equation with periodic boundary conditions

$$-(\varphi_p(x'))' + q(t)x = f(t, x, x''),\ t \in (0, T),$$
$$x(0) = x(T),\ x'(0) = x'(T).$$

The nonlinear term is Carathéodory with respect to $L^1[0, T]$. We employ coincidence degree theory to establish our results. (Received August 22, 2011)

1074-34-250 **Lynn Erbe**, **Gro Hovhannisyan** and **Allan Peterson*** (apeterson@math.unl.edu), 237 Avery, Lincoln, NE 685880130. *On the number of generalized zeros of solutions of a second order dynamic equation on a time scale.* Preliminary report.

By using the Jeffreys, Wentzel, Kramers and Brillouin (JWKB) approximation method we derive an asymptotic formula for the number of generalized zeros of (nontrivial) solutions of a second order dynamic equation on a time scale. (Received August 22, 2011)

35 ► Partial differential equations

1074-35-29 **Vasilii V. Kurta*** (vvk@ams.org), Mathematical Reviews, 416 Fourth Street, P.O. Box 8604, Ann Arbor, MI 48107. *A Liouville comparison principle for entire weak sub- and super-solutions of the equation $w_t - \Delta_p(w) = |w|^{q-1}w$.*

We establish a Liouville comparison principle for entire weak sub- and super-solutions of the equation $(*)$ $w_t - \Delta_p(w) = |w|^{q-1}w$ in the half-space $\mathbb{S} = \mathbb{R}^1_+ \times \mathbb{R}^n$, where $n \geq 1$, $q > 0$ and $\Delta_p(w) := \mathrm{div}_x\left(|\nabla_x w|^{p-2}\nabla_x w\right)$, $1 < p \leq 2$. In our study we impose neither restrictions on the behaviour of entire weak sub- and super-solutions on the hyper-plane $t = 0$, nor any growth conditions on their behaviour and on that of any of their partial derivatives at infinity. We prove that if $1 < q \leq p - 1 + \frac{p}{n}$, and u and v are, respectively, an entire weak super-solution and an entire weak sub-solution of $(*)$ in $\mathbb{S}$ which belong, only locally in $\mathbb{S}$, to the corresponding Sobolev space and are such that $u \leq v$, then $u \equiv v$. The result is sharp. As direct corollaries we obtain both new and known Fujita-type and Liouville-type results. (Received July 08, 2011)

1074-35-66 **Gro Hovhannisyan*** (ghovhann@kent.edu), 6000 Frank ave NW, North Canton, 44720. *Poisson's inequality for a Dirichlet problem on a time scale.* Preliminary report.

Consider Dirichlet boundary value problem in the circle

$$u^{\Delta\Delta}(r,\varphi) + \frac{u^{\Delta}(r,\varphi)}{\sigma(r)} + \frac{u_{\varphi\varphi}(r,\varphi)}{r\sigma(r)} = 0, \quad 0 < r < r_0, \quad 0 \leq \varphi \leq 2\pi,$$

$$u(r_0,\varphi) = f(\varphi),$$

where u_φ is derivative by continuous variable $\varphi \in [0, 2\pi]$, u^{Δ} is the delta derivative by variable r on a time scale $\mathbb{T}$, $\sigma(r)$ is the forward jump operator, $r_0 \in \mathbb{T}$, $\quad u : \mathbb{T} \times [0, 2\pi] \to R$.

By separation of variables for solutions $u(r,\varphi) \in C^{(2,2)}_{rd}(\mathbb{T}, [0, 2\pi])$ of the Dirichlet problem we prove the Poisson's inequality

$$u(r,\varphi) \leq \frac{1}{\pi}\int_0^{2\pi} \frac{\left(1 - \exp\int_r^{r_0} \frac{2\Delta r}{r}\right) f(\alpha)d\alpha}{1 - 2\exp\int_r^{r_0} \frac{2\Delta r}{r}\cos(\alpha - \varphi) + \exp\int_r^{r_0} \frac{2\Delta r}{r}}.$$

(Received August 08, 2011)

1074-35-82 **Marcelo M Cavalcanti*** (mmcavalcanti@uem.br), Avenida Colombo 5790, Maringa, Parana 87020-900, Brazil. *The role of curvature and nonlinearities in stability of waves on compact surfaces.*

This talk is concerned with wave equations on compact surfaces subject to locally distributed damping. The presented geometric analysis allows for construction of surfaces comprised of multiple regions that satisfy the requisite geometric optics conditions, and regions without any geometric restrictions, but subjected to the influence of the interior and/or boundary damping. It is shown that the conditions on the parts of the surface without damping can be reformulated in terms of the Gaussian curvature. The results also accommodate dissipative feedbacks that may grow sub- or super-linearly at infinity, in which case the decay rates may depend on the smoothness of the trajectories. The analysis exhibits a "continuous trade-off" between the regularity of solutions, nonlinearity of the damping and the rate of energy decay. This is a joint work with Valéria Cavalcanti, Ryuichi Fukuoka and Daniel Toundykov. (Received August 10, 2011)

1074-35-83 **Valeria N Domingos Cavalcanti*** (vndcavalcanti@uem.br), Avenida Colombo 5790, Maringa, Parana , Brazil. *Decay of solutions to damped Korteweg-de Vries type equation.*

Results of decay in time of the energy in L^2-level related to the damped Korteweg-de Vries equation posed on infinite domains, will be established in this manuscript. We prove exponential decay rates of the energy associated with the initial value problem if the dissipative mechanism is localized, that is, the dissipation is effective outside a compact set. If this mechanism is full, we get a similar result in H^k-level, $k \in \mathbb{N}$. In addition, we present the decay in time of the energy in L^2-norm with respect to the initial boundary value problem posed on the right half-line by considering convenient conditions on the initial data and on the dissipative effect. This is a joint work with Marcelo Cavalcanti, Fábio Natali and Andrei Faminskii. (Received August 10, 2011)

1074-35-86 **Jing Zhang*** (jz4f@virginia.edu), Jing Zhang, Department of Mathematics, University of Virginia, Charlottesville, VA 22904, and **Irena Lasiecka** (il2v@virginia.edu), Irena Lasiecka, Department of Mathematics, University of Virginia, Charlottesville, VA 22904. *Uniform stablization for semilinear system of elasticity with nonlinear Neumann boundary damping.*

In this presentation, the following nonlinear system of elasticity is considered:

$$w_{tt} = Lw + f(w) \quad \text{in} \quad (0,\infty)\times\Omega \tag{1}$$

$$\sigma(w)\cdot\nu = -g(w_t) \quad \text{in} \quad (0,\infty)\times\Gamma_1 \tag{2}$$

$$w = 0 \quad \text{in} \quad (0,\infty)\times\Gamma_0 \tag{3}$$

$$w(0,x) = w_0(x), \quad w_t(0,x) = w_1(x) \quad \text{in} \quad \Omega \tag{4}$$

We first establish the wellposedness of the solution to the above system by using the nonlinear semigroup theory and approximation method. Then it is proved that under the assumption that the boundary velocity feedback is dissipative, the solution has uniform dacay rates. (Received August 11, 2011)

1074-35-88 **Bociu Lorena** and **Daniel Toundykov*** (dtoundykov2@unl.edu). *Attractor for a non-dissipative von Karman plate with damping in free boundary conditions.* Preliminary report.

I will discuss a plate equation suggested by a certain flow-structure interaction model: a von Karman plate with a first-order non-dissipative term in the interior, and subject to boundary damping acting through free boundary conditions. The resulting dynamical system does not possess a strict Lyapunov function on the "natural" energy space; as a result the boundedness of the energy, let alone existence of an absorbing ball, is a priori unknown. It will be shown that despite the lack of monotonicity and absence of interior dissipation this nonlinear flow may converge to a global compact attractor. (Received August 11, 2011)

1074-35-90 **Justin T Webster*** (jtw3k@virginia.edu), University of Virginia, Department of Mathematics, P. O. Box 400137, Charlottesville, VA 22904-4137. *Well-posedness and Asymptotic Behavior of Nonlinear Flow-Structure Interactions.*

Nonlinear oscillations of a thin, flexible structure interacting with a flow of gas are considered. The interaction takes place on the interface of the two media and is expressed via boundary conditions involving the acceleration potential of the flow and the structural down-wash. This produces a coupled PDE system involving a nonlinear plate equation coupled with a perturbed three-dimensional wave equation. The system possesses two important parameters: (1) U, the unperturbed flow velocity, and (2)γ, a term corresponding to rotational inertia in the plate's filaments. Existence and uniqueness of finite energy solutions will be discussed (with respect to the above parameters) for the von Karman, Berger, and general semilinear polynomial nonlinearities in the structural equation. Subsequently, long-time behavior of solutions for the structure in the presence of structural boundary damping will be analyzed. For Berger's nonlinearity, the existence of a global compact attractor will be shown; for the von Karman nonlinearity, a stronger damping mechanism -localized interior damping near the boundary of the structure- will be implemented to obtain the existence of an attractor. (Received August 11, 2011)

1074-35-109 **Yanqiu Guo*** (s-yguo2@math.unl.edu), Department of Mathematics, University of Nebraska-Lincoln, Lincoln, NE 68588, and **Mohammad A. Rammaha** (mrammaha1@math.unl.edu), Department of Mathematics, University of Nebraska-Lincoln, Lincoln, NE 68588. *Systems of Nonlinear Wave Equations with Damping and Supercritical Boundary and Interior Sources.*

We consider the local and global well-posedness of the coupled nonlinear wave equations

$$u_{tt} - \Delta u + g_1(u_t) = f_1(u,v)$$
$$v_{tt} - \Delta v + g_2(v_t) = f_2(u,v),$$

in a bounded domain $\Omega \subset \mathbb{R}^n$ with Robin and Dirichlét boundary conditions on u and v respectively. The nonlinearities $f_1(u,v)$ and $f_2(u,v)$ represent strong sources of supercritical order, while $g_1(u_t)$ and $g_2(v_t)$ act as damping. In addition, the nonlinear boundary condition on u, namely, $\partial_\nu u + u + g(u_t) = h(u)$ on Γ, also features $h(u)$, a boundary source, and $g(u_t)$, a boundary damping. By employing nonlinear semigroups and the theory of monotone operators, we obtain several results on the existence of local and global weak solutions, uniqueness, and the blow-up of solutions in finite time. (Received August 15, 2011)

1074-35-114 **Michael Shearer*** (shearer@ncsu.edu), Mathematics Department, NC State University, Raleigh, NC 27695, and **Kim Spayd** and **Zhengzheng Hu**. *Stability of planar interfaces in two-phase porous media flow.* Preliminary report.

Plane waves for two phase flow in a porous medium are modeled by the one-dimensional Buckley- Leverett equation, a scalar conservation law. We analyze stability of sharp planar interfaces to two-dimensional perturbations, which involves a system of partial differential equations. Linear stability analysis results in a description of the dispersion relation to leading order in the wave number, leading to a criterion that distinguishes between interfaces that are long-wave stable and those that are not. Numerical simulations of the full nonlinear system of equations, including dissipation and dispersion, illustrate the analytical results. (Received August 15, 2011)

1074-35-116 **Nicolae Tarfulea*** (tarfulea@purduecal.edu), Purdue University Calumet, Department of Mathematics, Hammond, IN 46323. *Controlling the Constraints in Hyperbolic Evolution Systems.* Preliminary report.

Various applications lead to first order symmetric hyperbolic (FOSH) systems of differential equations supplemented by constraint equations. Often, for the pure Cauchy problem the constraints are preserved by the evolution, but for an initial-*boundary* value problem, this will not be the case. It has become increasingly clear that in order for constraints to be preserved during evolution, the boundary conditions have to be chosen in an appropriate way. In this talk we consider boundary conditions for a FOSH system which are well-posed, and establish a sufficient condition for them to be constraint-preserving. Our condition is based on a second, extended FOSH system which we construct, and which we show is equivalent to the original one when the boundary conditions are constraint-preserving. We believe that for the extended system it will be easier to control constraint violations during numerical simulations, because of the way that the constraint directly enter the evolution, and so it may present a preferable alternative to the original system for numerical approximation. This is a joint work with Douglas N. Arnold, University of Minnesota. (Received August 15, 2011)

1074-35-124 **Volodymyr Borodin*** (vnboroda@gmail.com), 1540 Lascassas Pk., apt. 625, Murfreesboro, TN 37130. *Construction of Green's functions for two-dimensional Laplace equation in spherical coordinates.*

Green's function approach is a powerful tool in solving various boundary-value problems for partial differential equations. Once the Green's function for a homogeneous boundary-value problem is obtained, the finding solution of the corresponding inhomogeneous problem for any integratable right-hand side function is a matter of volume integration. Green's function approach is readily applicable for both ODE and PDE. In the present study, we deal with the two-dimensional Laplace equation written in geographical coordinates on a sphere. A number of well-posed boundary-value problems stated on a spherical biangle, triangle and rectangle are considered, with Dirichlet and Neumann boundary conditions imposed. For all considered cases, explicit analytical form of the Green's functions is obtained. (Received August 16, 2011)

1074-35-125 **Stephen Pankavich*** (pankavic@usna.edu), Department of Mathematics, United States Naval Academy, 572C Holloway Rd, Annapolis, MD 21402, and **Petronela Radu** (pradu@math.unl.edu), Department of Mathematics, University of Nebraska, Lincoln, Avery Hall 239, Lincoln, NE 68588. *Instability of steady states for damped nonlinear wave equations.*

We consider steady solutions of damped, semi-linear hyperbolic equations of the form $\partial_{tt}u+a(t)\partial_t u+Lu = f(x,u)$ where L is a second-order linear differential operator and the nonlinearity f is convex in u. It is proved that linear instability of such solutions with a positive eigenfunction implies nonlinear instability via either exponential growth as $t \to \infty$ or finite time blow-up. A few interesting examples, to which our main theorem is immediately applicable, are briefly discussed. (Received August 16, 2011)

1074-35-130 **Lorena V Bociu***, lvbociu@ncsu.edu, and **Jean-Paul Zolesio**. *On a coupled system of incompressible fluid and nonlinear elasticity.* Preliminary report.

The problem under consideration is the nonlinear coupling of Navier-Stokes and elasticity. I will present a completely new linearization, derived in view of the stability analysis. The linearization reveals the presence of the curvature on the common interface, which demonstrates that the free boundary plays a key role in the analysis of the coupled system and its influence can not be neglected. (Received August 17, 2011)

1074-35-132 **Petronela Radu*** (pradu@math.unl.edu), 203 Avery Hall, Lincoln, NE 68502. *Existence and blow up for nonlinear wave equations.*

The study of nonlinear wave equations poses nontrivial challenges since the waves do not follow the superposition principle. In this talk I will present a natural approach for the study of local in time existence of solutions which

is based on energy-type estimates the finite speed of propagation property and a patching argument first used by Crandall and Tartar to create an arbitrarily large solution from solutions on small domains. (Received August 17, 2011)

1074-35-182 **Erik S Van Vleck*** (erikvv@ku.edu), 405 Snow Hall, Department of Mathematics, University of Kansas, Lawrence, KS 66045. *Multi-Dimensional Stability of Discrete Traveling Waves.*

We establish asymptotic stability in of traveling waves for the Allen-Cahn equation on Z^2. The result is valid for waves facing the $(1,0)$ and $(1,1)$ directions. Under additional hypotheses the result is valid for waves facing any rational direction. The proof is based on the comparison principle and parabolic estimates. The chief difficulty in passing to the discrete setting is the anisotropy and non-locality of the discrete Laplacian. In overcoming these difficulties we obtain some heat kernel estimates for a particular non-self adjoint problem with non-constant coefficients. (Received August 20, 2011)

1074-35-236 **Matthias Eller*** (mme4@georgetown.edu), Department of Mathematics, Georgetown University, 37th & O Street NW, Washington, DC 20057. *On the unique continuation for some hyperbolic systems of PDE with time-independent C^1-coefficients.* Preliminary report.

Carleman estimates for some first-order elliptic systems are established. These estimates together with the FBI transform are then used to prove the unique continuation for the isotropic Maxwell equations and the isotropic elastic wave equations with time-independent coefficients of class C^1. Our approach follows ideas by L. Robbiano and D. Tataru. (Received August 22, 2011)

1074-35-241 **Milena Stanislavova*** (stanis@math.ku.edu) and **Atanas Stefanov**. *Linear stability analysis for traveling waves of second order in time PDE's.*

We study traveling waves φ_c of second order in time PDE's in the form $u_{tt}+Lu+N(u)=0$. The linear stability analysis for these models is reduced to the question for stability of quadratic pencils in the form $\lambda^2 Id+2c\lambda\partial_x+H_c$, where $H_c=c^2\partial_{xx}+L+N'(\varphi_c)$. If H_c is a self-adjoint operator, with a simple negative eigenvalue and a simple eigenvalue at zero, then we completely characterize the linear stability of φ_c. More precisely, we introduce an explicitly computable index $\omega^*(H_c)\in(0,\infty]$, so that the wave φ_c is stable if and only if $|c|\geq\omega^*(H_c)$. The results are applicable both in the periodic case and in the whole line case. As an application, we consider three classical models - the "good" Boussinesq equation, the Klein-Gordon-Zakharov (KGZ) system and the fourth order beam equation. (Received August 22, 2011)

1074-35-248 **Marta Lewicka***, lewicka@pitt.edu. *Existence and stability of viscoelastic shock profiles.*

We investigate existence and stability of viscoelastic shock profiles for a class of planar models including the incompressible shear case (studied by Antman and Malek-Madani). We establish that the resulting equations fall into the class of symmetrizable hyperbolic-parabolic systems, hence spectral stability implies linearized and nonlinear stability with sharp rates of decay. The new contributions are treatment of the compressible case, formulation of a rigorous nonlinear stability theory, including verification of stability of small-amplitude Lax shocks, and the systematic incorporation in our investigations of numerical Evans function computations determining stability of large-amplitude and or nonclassical type shock profiles. (Received August 22, 2011)

1074-35-267 **Atanas G. Stefanov***, 1460, Jayhawk blvd, Math. Dept., Lawrence, KS 66045, and **Vladimir Georgiev**. *Global regularity and scattering for quadratic Klein-Gordon equation in two space dimensions.*

We consider the quadratic Klein-Gordon equation in two space dimensions. We show that if the data is small in $H^{1+}(R^2)$, then the solutions are global and scatter as time goes to infinity. Previous results require (much) more smoothness and strong decay of the data. The approach is via the Shatah method of normal forms, which eventually transforms the equation to a cubic one, which is easier to handle. In order to close the argument however, we need to deal with non-standard (i.e. non Coifmann-Meyer) bilinear pseudo-differential symbols. (Received August 22, 2011)

1074-35-281 **Ciprian Foias** and **Michael Jolly*** (msjolly@indiana.edu), Indiana University, Department of Mathematics, Rawles Hall, Bloomington, IN 47405, and **Rostyslav Kravchenko** and **Edriss Titi**. *Asymptotic behavior of a determining form for the 2D Navier-Stokes equations.*

Recently we have developed a determining form, which is an ordinary differential equation in the Banach space of time-dependent functions taking values in the determining low modes of the Navier-Stokes equations (NSE). If the initial condition for the ODE is the low-mode projection of a solution on the global attractor of the NSE,

the solution of the determining form evolves as a traveling wave. In fact these are the only traveling waves for the determining form. In this talk we discuss how an arbitrary initial trajectory evolves under the flow of the determining form toward a solution of the NSE. (Received August 23, 2011)

1074-35-292 **Ryo Ikehata**, **Grozdena Todorova** and **Borislav Yordanov*** (yordanov@math.utk.edu). *On the Asymptotic Behavior of Strongly Damped Wave Equations.*

We consider the Cauchy problem for an abstract dissipative wave equation in a Hilbert space H, generalizing the wave equation with strong damping in $\mathbf{R}^n$ or exterior domain:

$$u''(t) + Au(t) + Au'(t) = 0, \quad t \in (0, \infty),$$
$$u(0) = u_0, \quad u'(0) = u_1.$$

Here A is a nonnegative self-adjoint operator with dense domain $\mathcal{D}(A) \subset H$ and $(\cdot)' = d/dt$.

Let $(u_0, u_1) \in D(A^{1/2}) \times H$ and set $\|u_0\|_V := (\|u_0\|^2 + \|A^{1/2}u_0\|^2)^{1/2}$. The mild solution $u(t)$ satisfies

$$\|u(t)\|^2 \leq C(t+1)(\|e^{-t\eta A}u_0\|^2 + \|e^{-t\eta A}u_1\|^2) + Ce^{-\eta t}(\|u_0\|_V^2 + \|u_1\|^2),$$

$$\|u(t) - u_{dif}(t)\|^2 \leq C(\|e^{-t\eta A}u_0\|^2 + \|e^{-t\eta A}u_1\|^2) + Ce^{-\eta t}(\|u_0\|_V^2 + \|u_1\|^2)$$

for all $t \geq 0$, where $\eta > 0$ and $C > 0$ are constants. The diffusion approximation $u_{dif}(t)$ is defined by

$$u_{dif}(t) = e^{-tA/2}\left(\cos tA^{1/2}u_0 + A^{-1/2}\sin tA^{1/2}u_1\right).$$

(Received August 23, 2011)

1074-35-294 **Mikil Foss** and **Joe Geisbauer*** (s-jgeisba1@math.unl.edu). *Partial regularity for subquadratic parabolic systems with continuous coefficients.*

In 1984, Campanato announced a proof that solutions to parabolic systems with continuous coefficients are partially Hölder continuous. Unfortunately, there were some errors in his argument that left the problem open except under certain dimensional restrictions. With the help of DiBenedetto's intrinsic geometry, we have established a general positive resolution to this problem in the subquadratic setting. The main idea for our proof is to employ the A-caloric approximation method developed by Duzaar and Mingione to closely approximate solutions to the problem with A-caloric mappings. I will outline the argument for the main result and discuss some of the major lemmas used. (Received August 23, 2011)

1074-35-311 **Jack Cooper*** (jscoope@clemson.edu). *Optimal source selection and sparsity regularization in diffuse optical tomography.* Preliminary report.

Diffuse optical tomography is field of high possibility in medical imaging technologies, but is hampered by the ill-posed nature of the parameter estimation inverse problem. To combat this, the distinguishability criteria of Isaacson and Knowles is extended to DOT for optimal source selection. The influence of function space and inner product selection is illustrated through simulation, and further, a min-max formulation is used to combine optimal source selection with sparsity regularization. This formulation for estimating the optical parameters is solved with a novel gradient based algorithm, the effectiveness of which is evaluated through several numerical simulations. (Received August 23, 2011)

37 ► Dynamical systems and ergodic theory

1074-37-1 **Lewis P Bowen*** (lpbowen@math.tamu.edu), Texas A&M University, Mailstop 3368, College Station, TX 78726. *Entropy theory for actions of sofic groups.*

In 1958, Kolmogorov defined the entropy of a probability measure preserving transformation. Entropy has since been central to the classification theory of measurable dynamics. In the 70s and 80s researchers extended entropy theory to measure preserving actions of amenable groups (Kieffer, Ornstein-Weiss). My recent work generalizes the entropy concept to actions of sofic groups; a class of groups that contains for example, all subgroups of GL(n,C). Applications include the classification of Bernoulli shifts over a free group, answering a question of Ornstein and Weiss. (Received May 07, 2011)

1074-37-43 **Lorenzo A Sadun*** (sadun@math.utexas.edu). *Tilings without finite local complexity.* Preliminary report.

If a non-periodic tiling has finite local complexity (FLC) with respect to translation, then it associated tiling space is a matchbox manifold – locally the product of a Cantor set and Euclidean space. Furthermore, the dynamics

of translations on the tiling space are related to the properties of C* algebras built from the transversal. When a tiling does not have FLC, the situation is more complicated (and more interesting). I will show how to construct such spaces and how to view the transversal, and will present some ergodic and topological results. This is joint work with Natalie Frank and Ian Putnam. (Received July 28, 2011)

1074-37-56 **Konstantin Medynets*** (medynets@math.ohio-state.edu), 231 west 18 avenue, Columbus, OH 43210. *Ergodic measures and characters of transformation groups.*

In the talk, we will discuss connections between invariant ergodic measures and characters of transformation groups of Bratteli diagrams. It is shown that the problem of finding characters is completely reduced to the description of ergodic measures. (Received August 04, 2011)

1074-37-65 **Youssef Naim Raffoul*** (youssef.raffoul@notes.udayton.edu), Department of Mathematics, Dayton, OH 45469-2316. *Necessary and sufficient conditions for uniform stability in Volterra systems of integro-dynamic equations on time scale.*

We consider the system of Volterra integro-dynamic equations

$$x^{\Delta}(t) = A(t)x(t) + \int_0^t B(t,s)x(s)\Delta s$$

and obtain necessary and sufficient conditions for the uniform stability of the zero solution employing the resolvent equation coupled with the variation of parameters formula. The resolvent equation that we use for the study of stability will have to be developed since it is unknown for time scales. At the end of the paper, we furnish an example in which we deploy an appropriate Lypunov functional.
(Received August 08, 2011)

1074-37-119 **Nhan-Phu Chung*** (phuchung@buffalo.edu), Department of Mathematics, SUNY at Buffalo, Buffalo, NY 14260. *The variational principle for topological pressures of actions by sofic groups.*

Sofic groups were first introduced by Mikhail Gromov as a common generalization of amenable groups and residually finite groups. In 2008, in a remarkable breakthrough, via modeling the dynamics of a measurable partition of probability space by means of partitions of a finite space, Lewis Bowen showed how to define entropy for measure-preserving actions of countable sofic groups. Later, using ideas in operator algebras, David Kerr and Hanfeng Li, developed a more general approach for both measure and topological sofic entropies and established the variational principle for this context.

In this talk, applying Kerr and Li's method, I will define the topological pressure for actions of sofic groups and establish the variational principle for topological pressure. (Received August 15, 2011)

1074-37-148 **Robin D. Tucker-Drob*** (rtuckerd@caltech.edu). *Ultraproducts of measure preserving actions and graph combinatorics.*

Given a sequence of standard measure spaces and a non-principal ultrafilter U on the natural numbers, the ultraproduct of these spaces with respect to U is defined, using the Loeb measure construction. We define on this space the ultraproduct action associated with a sequence of measure preserving actions of a countable group, and characterize the standard factors of this action. The methods are then applied to answer questions arising in graph combinatorics of group actions and in probability, and also to give a new proof that the Bernoulli shift action of a sofic group is sofic. This is joint work with C.T. Conley and A.S. Kechris. (Received August 23, 2011)

1074-37-150 **Kamran Reihani*** (reihani@math.ku.edu), 405 Snow Hall, Lawrence, KS 66045-7594. *Bundles carrying invariant structures for dynamical systems and their operator algebras.* Preliminary report.

Let X be a space in a certain category (e.g. measure space, topological space, metric space, smooth manifold, Riemannian manifold, etc.), and let Γ be group of automorphisms of the dynamical system (X, Γ) in the appropriate sense. In general, there is no guarantee for existence of a "compatible" Γ-invariant structure (e.g. measure, metric, differential form, Riemannian metric, etc.) on X. On the other hand, studying invariants of the orbit space or the crossed product algebra usually requires existence of such invariant structures. Following the philosophy of "reduction to type-II", one can circumvent the obstruction by passing to a "natural" extension (Y, Γ) of the original system, which will carry a Γ-invariant structure. The space Y is usually obtained by a bundle construction, which in simple cases is given by a skew or Cartesian product. We will discuss a few examples of such constructions. In measure category, this problem is naturally related to the modular theory of von Neumann algebras.

This is based on a joint work with Bill Paschke. (Received August 19, 2011)

1074-37-158 **Elvan Akin Bohner*** (akine@mst.edu), Department of Mathematics and Statistics, 400 W 12th Street, Rolla, MO 65409, and **Zuzana Dosla** and **Bonita Lawrence**. *Almost oscillatory three-dimensional dynamical systems.*

In this paper, we investigate oscillation and asymptotic properties for three dimensional systems of dynamic equations. (Received August 19, 2011)

1074-37-169 **Naomi Kochi*** (nkochi@unomaha.edu) and **Mihaela Theodora Matache**. *Mean-Field Boolean Model of a Signal Transduction Network.*

Signal transduction networks govern important cellular functions and have important biomedical implications. We provide a mean-field Boolean network model for a signal transduction network of a generic fibroblast cell. The network consists of several main signaling pathways with 130 nodes, each of which represents a signaling molecule (mainly proteins). Nodes are governed by Boolean dynamics including canalizing functions as well as totalistic Boolean functions that depend only on the overall fraction of active nodes. We categorize the Boolean functions into several different classes. Using a mean-field approach we generate a mathematical formula for the probability of a node becoming active at any time step. The model is shown to be a good match for the actual network. This is done by iterating both the actual network and the model and comparing the results numerically. Using the Boolean model it is shown that the system is stable under a variety of parameter combinations. It is also shown that this model is suitable for assessing the dynamics of the network under protein mutations. Analytical results support the numerical observations that in the long-run at most half of the nodes of the network are active. (Received August 19, 2011)

1074-37-172 **Volodymyr Nekrashevych*** (nekrash@math.tamu.edu), Department of Mathematics, Texas A&M University, College Station, TX 77843-3368. *Hyperbolic groupoids and their C^*-algebras.* Preliminary report.

We will discuss a notion of a hyperbolic groupoid, which is a generalization of different types of hyperbolic dynamical systems: Gromov hyperbolic groups acting on their boundaries, expanding maps, groupoids associated with Smale spaces and Anosov flows, etc. We will define duality theory for hyperbolic groupoids, and discuss its relation with C^*-algebras. Other properties of C^*-algebras associated with hyperbolic groupoids will be discussed. (Received August 19, 2011)

1074-37-314 **Sarah B Frick** (sarah.frick@furman.edu), Department of Mathematics, Furman University, 3300 Poinsett Highway, Greenville, SC 29613, and **Nicholas S Ormes*** (normes@du.edu), Department of Mathematics, University of Denver, 2360 S. Gaylord St, Denver, CO 80208. *Polynomial Odometers.*

In this talk, we will discuss a class of adic maps which we call "Polynomial Odometers". These are adic maps defined by a sequence of polynomials with positive integer coefficients. This class includes the well-studied Pascal and Stirling adic systems as well as the classical odometers. We describe the ordered groups associated for these systems and use this description to explore the space of invariant measures, a main subject of interest in this category. (Received August 23, 2011)

1074-37-324 **Antoine Julien*** (antoinej@uvic.ca). *Orbital equivalence relation on tiling spaces.*

An important class of non-periodic tilings give rise to tiling spaces which are Cantor sets. The relation on tilings of "being a translate of one another" is then a minimal and étale equivalence relation on this Cantor set.

In the case of self-similar aperiodic tilings, there is a canonical AF-subrelation. We investigate how the tiling equivalence relation and this AF-subrelation differ. This can be described by the mean of Bratteli diagrams.

This is joint work with Jean Savinien. (Received August 23, 2011)

39 ► Difference and functional equations

1074-39-96 **Chris R Ahrendt*** (ahrendcr@uwec.edu) and **Kevin A Ahrendt**. *Some results on the stability of the generalized exponential function on time scales.* Preliminary report.

We will present a quick overview of some of the results on this topic to date. Focusing our attention on isolated time scales, we will examine how the graininess affects the region in the complex plane for which the generalized exponential function is asymptotically stable. More precisely, given a time scale $\mathbb{T}$ and $t_0 \in \mathbb{T}$, we seek to find for what $z \in \mathbb{C}$ the unique solution of the initial value problem $y^{\Delta} = zy$, $y(t_0) = 1$ is such that $\lim_{t\to\infty} y(t) = 0$.

In particular, results that pertain to certain classes of time scales in which the graininess never repeats itself will be given. (Received August 12, 2011)

1074-39-111 **Ferhan M. Atici*** (ferhan.atici@wku.edu), Western Kentucky University, Dept. of Mathematics and Computer Science, Bowling Green, KY 42101, and **Paul W. Eloe**. *Gronwall's Inequality on Discrete Fractional Calculus.*

In this talk, we introduce discrete fractional sum equations and inequalities. Then we give an explicit solution to a discrete fractional sum equation. This allow us to state and prove the Gronwall's inequality on discrete fractional calculus. As a result, Gronwall's inequality for discrete calculus with nabla operator is obtained at the first time. We illustrate our results with an application. (Received August 15, 2011)

1074-39-135 **Lingju Kong*** (Lingju-Kong@utc.edu), Department of Mathematics, University of Tennessee at Chattanooga, Chattanooga, TN 37403, and **John R. Graef** and **Qingkai Kong**. *Existence of multiple solutions for a generalized discrete beam equation.*

We study the existence of multiple solutions for the generalized discrete beam equation

$$\Delta^4 u(t-2) - \alpha\Delta^2 u(t-1) + \beta u(t) = \lambda f(t, u(t)), \quad t \in [1, T]_{\mathbb{Z}},$$

together with the boundary condition

$$u(0) = \Delta u(-1) = \Delta^2 u(T) = 0, \quad \Delta^3 u(T-1) - \alpha\Delta u(T) = \mu g(u(T-1)),$$

where $T \geq 2$ is an integer, $[1, T]_{\mathbb{Z}} = \{1, 2, \ldots, T\}$, $\alpha, \beta, \lambda, \mu \in \mathbb{R}$ are parameters, $f \in C([1, T]_{\mathbb{Z}} \times \mathbb{R}, \mathbb{R})$, and $g \in C(\mathbb{R}, \mathbb{R})$. Various special cases of the above problem are also discussed. Examples are included to illustrate the results. (Received August 22, 2011)

1074-39-181 **Funda Ekiz*** (funda.ekiz393@topper.wku.edu), Western Kentucky University, Department of Mathematics and Computer Sci., Bowling Green, KY 42101, and **Ferhan M. Atici**. *The Rational Expectations: A New Formulation of the Single-Equation Model on Time Scales.* Preliminary report.

In this talk, we start with a brief history on the rational expectation models of economics. We introduce a single-equation rational expectation model on isolated time scales. We discuss the solution method that we formulated with the existed solution methods in the literature. Next we introduce a linear system of rational expectation models. We demonstrate that the system of rational expectation models can be obtained using some transformations on a single equation model with several future expectations of the endogenous variable. A method to solve such a system will be explained in details. We close our talk with some applications in economics. (Received August 20, 2011)

1074-39-190 **Raegan Higgins*** (raegan.higgins@ttu.edu), Box 41042, Lubbock, TX 79409-1042. *Oscillation of a Second-Order Linear Delay Dynamic Equation.* Preliminary report.

Using the method of upper and lower solutions and the Riccati transformation technique, we establish some sufficient conditions which ensure that every solution of the second-order linear delay dynamic equation

$$\left(p(t)y^{\Delta}(t)\right)^{\Delta} + q(t)y(\tau(t)) = 0$$

oscillates. These results extend some earlier ones for the case $p(t) = 1$. We illustrate our results with examples. (Received August 21, 2011)

1074-39-207 **Rajendra B Dahal*** (rdahal@coastal.edu), Dept of Mathematics and Statistics, Coastal Carolina University, P O Box 261954, Conway, SC 29526. *Existence of positive solutions of a two point boundary value problem for a singular nonlinear semipositone dynamic equations system.*

By constructing a special cone and employing the well known fixed point theorm from a book by Guo-Lakshmikantham we prove the existence of at least one positive solution for a two point boundary value problem for a singular nonlinear semipositone dynamic equations system. (Received August 21, 2011)

1074-39-249 **Lynn Erbe*** (lerbe2@math.unl.edu), Department of Mathematics, University of Nebraska, Lincoln, NE 68588, and **Allan Peterson** and **Baoguo Jia**. *Oscillation results for second order nonlinear dynamic equaations on time scales.*

We discuss some recent results for the second order Emden-Fowler equation in which certain positivity and integrability conditions on the coefficient functions are relaxed. These may be considered as extensions of well-known results of Belohorec, Kiguradze, and others. (Received August 22, 2011)

1074-39-261 **Heidi Berger*** (heidi.berger@simpson.edu), 701 N. C Street, Simpson College, Indianola, IA 50125. *Application of Time Scale Calculus to the Growth and Development in Populations of Stomoxys calcitrans.* Preliminary report.

Typical methods of sampling for groups of insects utilize purely temporal sampling intervals. However, arthropod developmental parameters are known to be directly proportional to measures of accumulated temperature. It has recently been demonstrated that population growth models for arthropods exhibit a higher degree of correlation with empirical data when values derived from temporal sampling regimes are transformed into a function of accumulated degree days above a lower developmental threshold. Here we considered the possibility of further enhancing the accuracy of population parameter estimates by employing alternative sampling methods which incorporate temperature accumulation. By testing two models in which sampling interval is the experimental variable, we demonstrate that a modified, theoretical regime which consists of sampling events evenly spaced with respect to degree days yields growth rate estimates with smaller total residual error. With these results, we proceed to propose that acquisition of poikilotherm population data could more effectively be conducted by employing a three-tiered system in which sampling frequency varies with temperature domains. (Received August 22, 2011)

45 ► Integral equations

1074-45-306 **Tadele A Mengesha***, Department of Mathematics, Penn State University, University Park, PA 16802. *Variational theory for some nonlocal problems.*

As a consequence of a new nonlocal characterization of Sobolev vector fields in the spirit of Korn's inequality, we prove the well-posedness of the linear Peridynamic equation. (Received August 23, 2011)

46 ► Functional analysis

1074-46-54 **Benton L Duncan*** (benton.duncan@ndsu.edu), Dept of Math #2750, North Dakota State University, PO Box 6050, Fargo, ND 58108. *Invariants for operator algebras of topological dynamics (Preliminary Report).* Preliminary report.

For nonselfadjoint graph operator algebras and the operator algebras of multivariable dynamics two key ingredients in their classification are the multiplicative linear functional and the two dimensional nest representations. We consider how these two ingredients work in a slightly more general setting. In addition we will view these two ingredients from a slightly different persepective to get more information about the associated algebras. (Received August 04, 2011)

1074-46-58 **Kamran Reihani*** (reihani@math.ku.edu), University of Kansas. *Spectral triples for equicontinuous actions and metrics on state spaces.*

Spectral triples are the core objects for studying metric aspects of noncommutative geometry. A spectral triple (A, H, D) consists of a C^*-algebra A represented on a Hilbert space H, along with a selfadjoint operator D on H with compact resolvent, which commutes with a dense subset of A modulo bounded operators. Using this data, Connes defined a pseudo-metric on the state space of A, which is a metric under certain conditions. Given a C^*-algebra A, how to construct a spectral triple, and whether the Connes pseudo-metric is a metric compatible with the w^*-topology on the state space of A are among the most fundamental problems in this context.

The main result to be presented in this talk is as follows. Suppose we are given a spectral triple (A, H, D) and an integer action on A. Then provided that the action satisfies a compatibility condition called equicontinuity, we can naturally construct a spectral triple for the crossed product $A \rtimes \mathbb{Z}$. Moreover, if the Connes metric on the state space of A induced by (A, H, D) is compatible with the w^*-topology, then so is the Connes metric for the constructed spectral triple for $A \rtimes \mathbb{Z}$.

This talk is based on a joint work with Jean Bellissard and Matilde Marcolli. (Received August 06, 2011)

1074-46-81 **Alan L. Paterson*** (apat1erson@gmail.com). *Contractive spectral triples for crossed products.* Preliminary report.

As observed by A. Connes, a spectral triple $(A, \mathcal{H}, D)$ encodes noncommutative metric structures. In a recent paper, Bellissard, Marcolli and Reihani investigated metric structures associated with a $\mathbb{Z}$-action on A, using metric notions such as isometric and equicontinuous. They constructed in the equicontinuous case a natural

"dual" spectral triple $(A \rtimes_\alpha \mathbb{Z}, \mathcal{K}, \widehat{D})$, and showed that the dual action of $\mathbb{T} = \widehat{\mathbb{Z}}$ on the crossed product $A \rtimes_\alpha \mathbb{Z}$ is actually isometric. The talk discusses a generalization of this result for an action of an arbitrary discrete group G. The proof uses the dual coaction of G on the reduced crossed product, and the canonical spectral triple for G associated with a word metric. The isometry condition has to be replaced by a contracting condition for the semigroup of states of $C_r^*(G)$. (Received August 10, 2011)

1074-46-95 **Sarah E Wright*** (swright@holycross.edu), Mathematics and Computer Science Dept., College of the Holy Cross, One College Street, Worcester, MA 01610. *Aperiodicity Conditions in Topological k-Graphs.*

By generalizing what we think of as a graph we increase the class of C*-algebras that can be viewed as graph-algebras. Two main generalizations are making the graphs multidimensional k-graphs (Kumjian and Pask) and giving the vertex and edge sets topologies (Katsura). Yeend combined these two generalizations and constructed topological k-graphs in his thesis. We'll see an introduction to each of these generalizations. Condition (L), "every cycle has an entry" first appeared in the literature in Kumjian, Pask, and Raeburn's paper on Cuntz-Krieger algebras of directed graphs. It provides a necessary condition for simplicity of the graph algebra. This condition has been generalized to the theory of topological graphs, k-graphs, and topological k-graphs. We'll see how these conditions present themselves in various examples as well as evidence of their importance in each of the theories. Each generalization of the aperiodicity condition, particularly those in the k-dimensional case, can be difficult to check for. We'll give some equivalent conditions to aperiodicity in topological k-graphs. We will also see examples of topological k-graphs in which one condition may be substantially easier to verify than the other conditions. (Received August 12, 2011)

1074-46-126 **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 **Oleg Friedman*** (friedman001@yahoo.com), University of South Africa, Pretoria, RSA, current address Touro College / LCM, 7531 150th Street, Kew Gardens Hills, NY 11367. *On Jordan-Grothendieck type theorem for dual characterization of real locally C*-algebras.*

We obtain the following dual space characterization of real locally C*-algebras among real lmc*-algebras: Theorem. A real lmc*-algebra is a real locally C*-algebra iff it is symmetric, and each continuous Hermitian linear function on it is a difference of two continuous positive linear functionals. (Received August 17, 2011)

1074-46-157 **Taylor Hines*** (thines@math.purdue.edu), Department of Mathematics, Purdue University, 150 N. University Street, West Lafayette, IN 47907-2067, and **Andrew Toms**. *The radius of comparison for crossed products and mean topological dimension.* Preliminary report.

The radius of comparison of a C^*-algebra A is an invariant extending the topological (covering) dimension for noncommutative spaces. In the case that A is the crossed product of a topological dynamical system on a finite-dimensional space, several results exist which bound the radius of comparison in terms of the dimension of the underlying space. Our work is an attempt to extend results of this type to dynamical systems on infinite-dimensional spaces using the mean topological dimension. This talk summarizes recent progress by Q. Lin, N.C. Phillips, A. Toms and others towards giving the radius of comparison of a minimal system in terms of its mean dimension. We also discuss current conjectures and recent results which give evidence for the conjecture that the radius of comparison of the crossed product algebra of a minimal system is approximately half the mean dimension. (Received August 19, 2011)

1074-46-203 **Upasana Kashyap*** (ukashyap1@citadel.edu), Dept. of Mathematics and Computer Science, The Citadel, 171 Moultrie Street, Charleston, SC 29409. *The Maximal W*-dilation and Morita Equivalence.*

We consider the theory of the W*-dilation which connects the non-selfadjoint dual operator algebra with the W*-algebraic framework. In particular, we use the maximal W*-algebra C generated by a dual operator algebra M. Every dual operator M-module dilates to a dual operator module over C which is called the "maximal dilation". We show that every dual operator module is a weak*-closed submodule of its maximal dilation. Indeed, in the case of weak* Morita equivalence this maximal dilation turns out to be a W*-module over C. The theory of the W*-dilation is a key part of the proof Morita II theorem for dual operator algebras. (Received August 21, 2011)

1074-46-204 **Frederic Latremoliere*** (frederic@math.du.edu). *C*-algebraic characterization of bounded orbit injection equivalence for minimal free Cantor systems.*

Bounded orbit injection equivalence is an equivalence relation defined on minimal free Cantor systems which is a candidate to generalize flip Kakutani equivalence to actions of the Abelian free groups on more than one generator. This paper characterizes bounded orbit injection equivalence in term of a mild strengthening of Rieffel-Morita equivalence of the associated C*-crossed-product algebras. Moreover, we show that bounded orbit injection equivalence may be strengthened to orbit equivalence or even strong orbit equivalence under conditions on some dimension groups which we prove are invariant for bounded orbit injection equivalence, while being different in general from the K0-groups of the associated C*-crossed-products. (Received August 21, 2011)

1074-46-218 **Ping Wong Ng*** (png@louisiana.edu), Lafayette, LA 70504. *Algebraic and quasiequivalence of type III representations of simple nuclear C*-algebras.* Preliminary report.

In this short paper, we derive some consequences of our von Neumann algebra uniqueness theorem (solving a problem of Kishimoto).

Among other things, we prove the following:

Let A be a separable simple nuclear C*-algebra and let π_1, π_2 be nondegenerate type III representations of A on a separable Hilbert space. Then π_1 and π_2 are algebraically equivalent if and only if there exists an asymptotically inner automorphism α on A such that $\pi_1 \circ \alpha$ and π_2 are quasiequivalent. (Received August 22, 2011)

1074-46-233 **Alan Wiggins*** (adwiggin@umd.umich.edu), Department of Mathematics and Statistics, 2014 CASL Building, 4901 Evergreen Road, Dearborn, MI 48128. *Further Results on Strong Singularity for Subfactors.* Preliminary report.

The strong-singularity constant α for an inclusion $N \subset M$ of II_1 factors is a number between 0 and 1 that measures how "close" N is to its conjugates by unitaries in M relative to how close the unitaries are to N. It is nonzero if and only if N is singular, i.e., has no nontrivial normalizing unitaries, in M. In work with Pinhas Grossman, we exhibited a pair $N \subset M$ such that $0 < \alpha < 1$. We shall discuss further refinements for global (lower) bounds on the strong singularity constant, more examples of inclusions with $0 < \alpha < 1$, and the situation in infinite Jones index. This is joint with Pinhas Grossman. (Received August 22, 2011)

1074-46-239 **Ionut Chifan** and **Thomas Sinclair*** (thomas.sinclair@math.ucla.edu), UCLA Mathematics Department, Box 951555, Los Angeles, CA 90095-1555. *Von Neumann Algebras of Hyperbolic Groups.*

We will describe some operator-algebraic consequences of negative curvature in the theory of countable discrete groups, with applications to the structural theory of II_1 factors and measured group theory. (Received August 22, 2011)

1074-46-284 **José R. Carrión*** (jcarrion@math.purdue.edu), Department of Mathematics, Purdue University, West Lafayette, IN 47907. *G-odometers and classification of C^*-algebras.*

A (discrete) residually finite group G acts on a profinite completion $\tilde{G}$ by left translation. These G-odometers generalize the notion of an odometer corresponding to the case $G = \mathbb{Z}$. We study the classification of the corresponding crossed product C^*-algebra $C(\tilde{G}) \rtimes G$ via K-theoretical invariants.

The eponymous C^*-algebras considered by Bunce and Deddens in the 1970s may be regarded as the case $G = \mathbb{Z}$ and, in analogy with this case, the so-called generalized Bunce-Deddens algebra $C(\tilde{G}) \rtimes G$ was shown by Orfanos to be simple, separable and nuclear, and to have real rank zero and stable rank one. We show that for a large class of groups (which includes the discrete Heisenberg group, for example) the corresponding generalized Bunce-Deddens algebra is classified by its Elliott invariant. (Received August 23, 2011)

1074-46-325 **Andrew K. Greene*** (andrew-greene@uiowa.edu), Department of Mathematics, University of Iowa, Iowa City, IA 52242. *Extensions of Hilbert Modules over Operator Tensor Algebras.* Preliminary report.

Given a C^*-correspondence E over a C^*-algebra A, one may form the tensor algebra $\mathcal{T}_+(E)$, a noncommutative generalization of the classical disc algebra. J. Carlson and D. Clark in *J. Funct. Anal.* **128** (1995), no. 2, 278–306., defined Ext groups for Hilbert modules over the disc algebra. We extend their methods to Hilbert modules over $\mathcal{T}_+(E)$. (Received August 23, 2011)

1074-46-332 **Kate Juschenko* & Kenneth Dykema** (kate.juschenko@gmail.com), Department of Mathematics, Mailstop 3368 Texas A, College Station, TX 77843-3368. *Second moments of unitaries in a II_1-factor.*

We will consider convex sets of matrices composed of second-order mixed moments of n unitaries with respect to finite traces. These sets are of interest in connection with Connes' embedding problem. We overview the basic facts about Connes' embedding problem. In particular, we will discuss a theorem of E. Kirchberg which was the main motivation to study matrices of second-order moments. We present some properties of these sets and descriptions in case of small n. We also discuss a connection with the sets of correlation matrices and give some related examples. (Received August 24, 2011)

1074-46-333 **Gabriel Nagy** and **Sarah A Reznikoff*** (sarahrez@ksu.edu), 138 Cardwell, Manhattan, KS 66502. *Pseudo Diagonals of C*-Algebras.*

To capture the properties enjoyed by a particular natural subalgebra of a graph algebra, we define the notion of an "abelian core" of a C*-algebra. The abelian core of a graph algebra resembles a Kumjian C*-Diagonal but fails to satisfy the extension property; we relax this condition to define a "pseudo diagonal", and prove that every pseudo-diagonal is an abelian core. (Received August 24, 2011)

47 ► Operator theory

1074-47-47 **Catalin Georgescu** (Catalin.Georgescu@usd.edu) and **Gabriel Picioroaga*** (Gabriel.Picioroaga@usd.edu). *Fuglede-Kadison determinants for operators in the von Neumann algebra of an equivalence relation.*

We calculate the Fuglede-Kadison determinant for operators of the form $\sum_{i=1}^{n} M_{f_i} L_{g_i}$ where L_{g_i} are unitaries or partial isometries coming from Borel (partial) isomorphisms g_i on a probability space which generate an ergodic equivalence relation, and M_{f_i} are multiplication operators. We obtain formulas for the cases when the relation is treeable or the f_i's and g_i's satisfy some restrictions. (Received August 01, 2011)

1074-47-91 **Rufus Willett*** (rufus.willett@vanderbilt.edu), 1326 Stevenson Center, Vanderbilt University, Nashville, TN. *Rigidity of Roe algebras.*

Roe algebras associated to a metric space X are noncommutative C*-algebras that attempt to capture the large-scale geometry of X. If X is a discrete group G equipped with a word metric, then the (uniform) Roe algebra of X is the crossed product associated to the action of G on its Stone-Cech compactification. Roe algebras are important in higher index theory on open manifolds, and its applications to topology and geometry.

Motivated by these applications, we show that in a large class of situations the Roe algebra completely determines X, i.e. if X and Y are spaces having isomorphic Roe algebras, then they have the same large scale geometry - in the group case, this means that the associated groups are quasi-isometric.

This is joint work with Jan Spakula. (Received August 12, 2011)

1074-47-128 **Geoff R Goehle*** (grgoehle@email.wcu.edu), 452 Stillwell Hall, Dept. of Mathematics and Computer Science, Western Carolina University, Cullowhee, NC 28723. *The Spectrum of Groupoid C*-algebras.*

Groupoids are very general objects which can be constructed from, among other things, actions of groups on topological spaces. Any groupoid G contains a group bundle S called the stabilizer bundle. In the transformation group case the fibres of this bundle are the isotropy subgroups associated to the group action. When S has a Haar system and the orbits of the groupoid (or associated group action) are closed then we can use the irreducible representations of the fibres of the stabilizer bundle to understand the representations of the groupoid. Specifically the spectrum of the groupoid C^*-algebra $C^*(G)$ is homeomorphic to the orbit space arising from a natural action of G on the spectrum of $C^*(S)$. In the transformation group case this allows us to describe the irreducible covariant representations of the group action in terms of the representations of the isotropy groups. (Received August 17, 2011)

1074-47-179 **Raul E Curto*** (raul-curto@uiowa.edu), Department of Mathematics, The University of Iowa, Iowa City, IA 52242. *Operators Cauchy Dual to 2-hyperexpansive Operators: The Multivariable Case.*

In joint work with Sameer Chavan, we introduce an abstract framework to study generating m-tuples, and use it to analyze hypercontractivity and hyperexpansivity in several variables. These two notions encompass (joint) hyponormality and subnormality, as well as the study of toral and spherical isometries; for instance, the Drury-Arveson 2-shift is a spherical complete hyperexpansion.

Our approach produces a unified theory that simultaneously covers toral and spherical hypercontractions (and hyperexpansions). As a byproduct, we arrive at a dilation theory for completely hypercontractive and completely hyperexpansive generating tuples. We can then analyze in detail the Cauchy duals of toral and spherical 2-hyperexpansive tuples. We also discuss various applications. (Received August 20, 2011)

1074-47-186 **Justin R Peters*** (peters@iastate.edu), Department of Mathematics, Iowa State University, Ames, IA 50011. *Operator algebras from abelian semigroup actions.*

Let $\mathcal{S}$ be a discrete abelian semigroup with cancellation and identity element which acts by continuous surjections on a compact metric space X by an action σ. Form an algebra $\mathcal{A}_0$ which contains the continuous complex valued functions $C(X)$ together with formal operators $S_t,\ t \in \mathcal{S}$, satisfying the commutation relaction

$$fS_t = S_t f \circ \sigma, \quad f \in C(X),\ t \in \mathcal{S}.$$

Thus a typical element of $\mathcal{A}_\prime$ has the form $\sum_{t\in\mathcal{S}} S_t f_t$ where the sum is finite.

We consider two classes of (Hilbert space) representations, the left regular representations and the orbit representations. If $\mathcal{A}_0$ is completed in the norm obtained by taking the supremum over the class of left regular representations, an Operator algebra $\mathcal{A}$ is obtained. We discuss the C*-envelope of $\mathcal{A}$. The left regular representations turn out to be Shilov, while a certain class of orbit representations has a Shilov resolution.

The talk is based on joint work with Benton Duncan. (Received August 20, 2011)

1074-47-195 **Alvaro Arias*** (aarias@math.du.edu), 2360 south Gaylord street, Denver, CO 80208, and **Frederic Latremoliere** (frederic@math.du.edu), 2360 south Gaylord Street, Denver, CO. *Isomorphism of noncommutative domain algebras.*

Noncommutative domain algebras were introduced by recently by Gelu Popescu. They provide a generalization of noncommutative disk algebras and serve as universal operator algebras for a large class of noncommutative domains, i.e. noncommutative analogues of domains in C^n.

In this talk we extend results of our previous work on the classification on noncommutative domain algebras up to completely isometric isomorphism. We use the classification of Reinhardt domains by Sunada and a combinatorial argument to provide a complete classification a large class of noncommutative domain algebras in terms of their defining symbol.

We also show that the several complex variable techniques we used to investigate the isomorphism problem give a conceptually simple and transparent proof of Popescu's Cartan's Lemma. (Received August 21, 2011)

1074-47-213 **Vrej A Zarikian*** (zarikian@usna.edu). *A New Proof of Mercer's Theorem.* Preliminary report.

A *Cartan bimodule algebra* is a weakly-closed non-self-adjoint algebra A sitting between a von Neumann algebra M and a Cartan subalgebra D, such that A generates M as a von Neumann algebra. For example, the upper-triangular 2×2 matrices sitting between the 2×2 matrices and the 2×2 diagonal matrices. A *Cartan bimodule isomorphism* is an isometric isomorphism $\theta : A_1 \to A_2$ between Cartan bimodule algebras such that $\theta(D_1) = D_2$. Mercer's Theorem (1991) states that every Cartan bimodule isomorphism $\theta : A_1 \to A_2$ extends to a *-isomorphism $\overline{\theta} : M_1 \to M_2$ of the containing von Neumann algebras. Mercer's proof relies on an intricate analysis of the Feldman-Moore equivalence relations associated with the inclusions $D_1 \subseteq M_1$ and $D_2 \subseteq M_2$. In this talk, based on joint work-in-progress with Jan Cameron and David Pitts, I give a new proof of Mercer's Theorem which is more operator-algebraic in flavor, depending instead on an automatic complete boundedness result of Pitts (2008). This proof, though still involved, is more transparent and suggests an interesting direction for future research, namely trying to prove Mercer's Theorem in the norm context. (Received August 22, 2011)

1074-47-260 **Will Grilliette*** (w.b.grilliette@gmail.com), 34 Glen St. #103, Alfred, NY 14802. *Combinatorial Algebra for Normed Structures.* Preliminary report.

In this talk, I present some recent results in applying classical combinatorial methods to normed algebras. Specifically, I will demonstrate a modified presentation theory for C*-algebras, which produces an associated Tietze transformation theorem.

I will also discuss current progress in adapting these methods to other normed structures. In the Banach algebra case, many of the methods are immediately borrowed from the C*-algebra case, yielding the transformational calculus. However, for the theorem, more care must be taken in the lifting arguments. (Received August 22, 2011)

1074-47-280 **Rich Avery*** (rich.avery@dsu.edu). *Multiple Fixed Point Theorems Utilizing Operators and Functionals of Leggett-Williams Type.*

In this presentation, multiple fixed point theorems utilizing operators and functionals in the spirit of the original Leggett-Williams fixed point theorem (void of any invariance like conditions) will be presented. The underlying sets in the Leggett-Williams fixed point theorem that were defined using the total order of the real numbers are replaced by sets that are defined using an ordering generated by a border symmetric set. The talk will focus on the defining characteristic of Leggett-Williams type fixed point arguments and the need for border symmetric sets in the versions that utilize both operators and functionals in defining the underlying sets to apply index arguments. (Received August 23, 2011)

1074-47-283 **David Milan*** (dmilan@uttyler.edu) and **Benjamin Steinberg** (bsteinbg@math.carleton.ca). *Viewing tight inverse semigroup algebras as partial crossed products.*

Many C*-algebras such as Cuntz algebras and graph algebras are generated by an inverse semigroup of partial isometries. Exel defined tight representations of inverse semigroups in order to enforce Cuntz-type relations on general inverse semigroups. We give a partial crossed product description of tight inverse semigroup algebras, the algebras that are universal for tight representations, and use it to study ideals and simplicity. (Received August 23, 2011)

1074-47-300 **Jan M. Cameron*** (jacameron@vassar.edu), 124 Raymond Avenue, Poughkeepsie, NY 12604. *Perturbations of crossed product II_1 factors.* Preliminary report.

In 1972, Kadison and Kastler introduced a uniform metric on the collection of all closed subalgebras of the bounded operators on a Hilbert space, and conjectured that sufficiently close operator algebras are spatially isomorphic. In the von Neumann algebra setting, the conjecture has been established in a number of cases, such as when one of the von Neumann algebras is type I or injective. We prove Kadison and Kastler's conjecture for a class of non-injective, finite von Neumann algebras arising as crossed products. In particular, if M is a II_1 factor of the form $L^\infty(X,\mu) \rtimes_\alpha \mathbb{F}_r$, for a free, ergodic, measure-preserving action of a free group $\mathbb{F}_r$ on a probability space (X,μ), then any von Neumann algebra N sufficiently close to M is isomorphic to M. This is joint work with Erik Christensen, Allan Sinclair, Roger Smith, Stuart White, and Alan Wiggins. (Received August 23, 2011)

1074-47-307 **Elias Katsoulis*** (katsoulise@ecu.edu), Department of Mathematics, East Carolina University, Greenville, NC 27858. *Contributions to the theory of C^*-correspondences.* Preliminary report.

We discuss our recent work with E. Kakariadis regarding adding tails to C^*-correspondences as well as some forthcoming work with the same author. (Received August 23, 2011)

1074-47-331 **Craig Kleski*** (ckleski@virginia.edu). *Boundaries for operator systems.*

In 2006, Arveson resolved a long-standing problem by showing that for any element x of a separable self-adjoint unital subspace S of $B(H)$, the norm of x is $\sup\|\pi(x)\|$, where π runs over the boundary representations for S. We show that "sup" can be replaced by "max". This implies that the Choquet boundary for a separable operator system is a boundary in the classical sense. (Received August 24, 2011)

49 ► Calculus of variations and optimal control; optimization

1074-49-4 **Emmanuel Candes*** (candes@stanford.edu). *Recovering the unseen: Some recent advances in low-rank matrix reconstruction.*

We discuss two surprising phenomena. The first is that one can recover low-rank matrices exactly from what appear to be highly incomplete sets of sampled entries; that is, from a minimally sampled set of entries. Further, perfect recovery is possible by solving a simple convex optimization program, namely, a convenient semidefinite program. The second is that exact recovery via convex programming is further possible even in situations where a positive fraction of the observed entries are corrupted in an almost arbitrary fashion. These facts have lots of consequences and applications we shall discuss. (Received August 29, 2011)

1074-49-247 **Marta Lewicka***, lewicka@pitt.edu. *Infinitesimal isometries on developable surfaces and asymptotic theories of elastic developable films.*

The purpose of this talk is to introduce the audience to the rigorous mathematical derivation of lower-dimensional theories of thin elastic films (for example, the well-known von-Karman equations arise naturally in this context).

The new results I will present (obtained in collaboration with Pakzad and Hornung) are a study regularity, rigidity, density and matching properties for Sobolev- regular isometries on developable surfaces without affine regions. We prove that given enough regularity of the surface, any first order isometry can be matched to an isometry of an arbitrarily high order. We then discuss the consequences of these results for the elasticity of thin developable shells. (Received August 22, 2011)

55 ► Algebraic topology

1074-55-78 **Kristopher Williams*** (kristopher.williams@doane.edu), Doane College, 1014 Boswell Ave, Crete, NE 68333. *Complements of line arrangements in the complex projective plane.* Preliminary report.

A hyperplane arrangement is a finite collection of hyperplanes in a vector space. When we let the vector space be the complex plane, the complement of the arrangement is a real, four-dimensional manifold. One of the main areas of study in arrangement theory is determining how the intersections of the hyperplanes (combinatorics) affects the topology of the complement of the arrangement.

It is known that there are pairs of arrangement complements that are combinatorially the same, but whose fundamental groups are not isomorphic. We give a complete classification of combinatorial types for arrangement complements that have fundamental groups isomorphic to direct products of free groups. We end with a discussion of arrangements whose complements have fundamental groups isomorphic to direct products of groups that are not necessarily free. (Received August 10, 2011)

1074-55-282 **Max Forester***, Mathematics Department, University of Oklahoma, Norman, OK 73019. *Promotion maps for group actions.* Preliminary report.

I will discuss promotion maps, which are natural homomorphisms in homology associated to a finite group action. (Received August 23, 2011)

57 ► Manifolds and cell complexes

1074-57-45 **Carmen Caprau*** (ccaprau@csufresno.edu), Department of Mathematics, California State University, Fresno, 5245 North Backer Avenue M/S PB 108, Fresno, CA 93740, and **James Tipton**. *The Kauffman polynomial and trivalent graphs.*

We construct a state model for the two-variable Kauffman polynomial using planar trivalent graphs. We also use this model to obtain a polynomial invariant for trivalent graphs embedded in $\mathbb{R}^3$. (Received July 31, 2011)

1074-57-68 **Charles D Frohman*** (charles-frohman@uiowa.edu), **Michael C Fitzpatrick** (Michael-C-Fitzpatrick@uiowa.edu) and **Joann Kania-Bartoszynska** (jkaniab@nsf.gov). *Projective representations of the mapping class groups of surfaces coming from extended TQFT.*

We will discuss the structure of 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)

1074-57-69 **Thang LE***, letu@math.gatech.edu, and **Anh TRAN**. *On the AJ Conjecture.*

We consider the AJ conjecture which relates the A-polynomial and the colored Jones polynomial of a knot. Using the skein theory, we show that the conjecture holds true for some classes of two-bridge knots and pretzel knots. Along the way, we also compute the universal character ring of $(-2, 3, 2n + 1)$-pretzel knots explicitly and show that they are reduced. (Received August 08, 2011)

1074-57-92 **Heather A Dye*** (mathheather@gmail.com). *Smoothed Parity Invariants.*

The parity of crossings in a knot diagrams can be used to augment existing knot invariants such as the Jones polynomial. I introduce two new invariants based on combinatorial sums determined by parity. The first knot invariant is based on sums of linking numbers. The second is an invariant of flat virtual knot diagrams and is a formal sum of diagrams. (Received August 12, 2011)

1074-57-113 **Keiko Kawamuro*** (kawamuro@iowa.uiowa.edu), 14 McLean Hall, Iowa City, TX 52242. *Open book foliations and contact manifolds.*

I will introduce an open book foliation and show applications to study of contact manifolds. This is a joint work with Testuya Ito. (Received August 15, 2011)

1074-57-121 **Sam Nelson*** (sam.nelson@cmc.edu), Department of Mathematical Sciences, 850 Columbia Ave, Claremont, CA 91711. *Twisted Virtual Biracks.*

Virtual links may be understood as equivalence classes of links in manifolds of the form $\Sigma \times [0,1]$ where Σ is a compact orientable surface. If we generalize to allow non-orientable surfaces, we obtain twisted virtual links.

In this talk we introduce an algebraic structure called a twisted virtual birack which defined counting invariants for twisted virtual links. As an application, we show how to use finite twisted virtual biracks to classify twisted structures on a virtual link diagram. (Received August 16, 2011)

1074-57-134 **David Futer**, **Efstratia Kalfagianni** and **Jessica S Purcell*** (jpurcell@math.byu.edu), Mathematics Department, Brigham Young University, Provo, UT 84602. *Guts of surfaces and the colored Jones polynomial.*

We derive relations between the coefficients of colored Jones polynomials and the topology of incompressible spanning surfaces in knot and link diagrams, for A-adequate links. This allows us to detect fibers and bound volumes for large classes of knots and links. Our approach is to generalize the checkerboard surfaces of alternating knot decompositions, show these surfaces are incompressible, and obtain a polyhedral decomposition of their complement. This allows us to relate the geometry of the complement to spines of the checkerboard surface (state graphs), which in turn are related to coefficients of the Jones polynomial. (Received August 17, 2011)

1074-57-151 **Yo'av Rieck*** (yoav@uark.edu), Math Department, Fayetteville, AR 72701, and **Yasushi Yamashita**. *Cosmetic surgery on links and the link volume of hyperbolic 3-manifolds.*

Let $L \subset S^3$ be a link, and denote the components of L by $K_1, \ldots, K_n$. Let α_1 be a slope on K_1. We say that α_1 can be completed to a cosmetic surgery if there exists slopes α_i on K_i $(i = 2, \ldots, n)$ so that surgery on L with the given slopes gives S^3.

In some cases (for example, the Hopf link) every slopes on K_1 can be completed to a cosmetic surgery. We give a necessary and sufficient condition for this to happen, and prove that when this does not happen, the set of slopes on K_1 that can be completed is very small (in a sense that will be described in the talk). We prove similar theorem for cosmetic surgery on links in some other manifolds (hyperbolic manifolds, solid torus, and $T^2 \times I$).

The proof is inductive, and for the induction we associate a finite tree with the manifold $S^3 \setminus N(L)$. The tree will be described in the talk.

We apply this to the link volume. The link volume of a closed oriented 3-manifold is an invariant that measures how efficiently the manifold can be represented as a cover of S^3. We prove the existence of hyperbolic manifolds of bounded volumes but unbounded link volumes. (Received August 19, 2011)

1074-57-162 **William H. Jaco*** (william.jaco@okstate.edu), Department of Mathematics, MSCS 401, Oklahoma State University, Stillwater, OK 74078, and **Jesse Johnson** and **Stephan Tillmann**. *Minimal triangulations for infinite families of 3–manifolds.* Preliminary report.

A notion of complexity for a 3–manifold is the minimal number of tetrahedra necessary for a (pseudo) triangulation of the manifold. We shall present results giving for the first time the complexities of several infinite families of 3–manifolds. In particular, we shall outline the proof that the complexity of the product of a closed orientable surface of genus g with an interval, $S_g \times I$, is $10g - 4$. Furthermore, we show that while the minimal triangulations fro these manifolds are not unique, they all have the form of an inflation of a cone over a minimal triangulation of the surface S_g. (Received August 19, 2011)

1074-57-166 **Shelly Harvey*** (shelly@rice.edu), Department of Mathematics, MS #136, Rice University, 6100 Main St., Houston, TX 77005, and **Danielle O'Donnol**. *Combinatorial Floer Homology for Spatial Graphs.*

A spatial graph is an embedding, $f : G \to S^3$, of a graph G. For each *balanced* and oriented spatial graph, $f(G)$, we define a combinatorial invariant $HFG^-(f(G))$ which is a bigraded module over a polynomial ring in $E + V$ variables, where V is the number of vertices and E is the number of edges in the graph. This invariant is a generalization of combinatorial link Floer homology defined by Manolescu, Ozsvath, Sarkar (MOS) for links in S^3. To do this, we define a grid diagram for a spatial graph and show that every embedding can be put into grid form. Following MOS, our invariant is the homology of a chain complex that counts certain rectangles in the

grid. Although the chain complex depends on the choice of grid, the homology depends only on the embedding. (Received August 19, 2011)

1074-57-196 **Moshe Cohen** and **Adam Lowrance*** (adam-lowrance@uiowa.edu), Department of Mathematics, 14 MacLean Hall, Iowa City, IA 52242-1419. *A categorification of the Tutte polynomial.* Preliminary report.

Given a graph or matroid, we define a triply graded homology theory whose filtered Euler characteristic is the Tutte polynomial. The construction mimics the construction of odd Khovanov homology. We discuss applications to alternating knots and links. (Received August 21, 2011)

1074-57-224 **Rachel Roberts***, Department of Mathematics, Washington University in St Louis, St Louis, MO 63130, and **William H. Kazez**. *Right-veering automorphisms of surfaces and overtwisted contact structures.* Preliminary report.

An open book decomposition of a 3-manifold is a decomposition of the 3-manifold into a fibered link l and the fibers of some fibration of the complement of l. Associated to an open book is a contact structure. Results of Honda-Kazez-Matic relate tightness of this contact structure to the fractional Dehn twist coefficient, a measure of the twisting of the monodromy about the boundary. Starting with work of Gabai, we give new counterexamples to a conjecture of Honda-Kazez-Matic. (Received August 22, 2011)

1074-57-237 **Kenneth L. Baker*** (kenken@math.miami.edu), Department of Mathematics, 1365 Memorial Drive, Ungar 515, Coral Gables, FL 33146, **Cameron Gordon**, Department of Mathematics, 1 University Station C1200, Austin, TX 78712, and **John Luecke**, Department of Mathematics, 1 University Station C1200, Austin, TX 78712. *Bridge Numbers and Integral Surgery.* Preliminary report.

What can one say about the bridge numbers of the knots K^n obtained by Dehn twisting a knot $K = K^0$ along an annulus $\widehat{R}$ it intersects? If this annulus lies on a Heegaard surface, then it is not hard to see the set of bridge numbers of these knots with respect to this Heegaard surface are bounded. We show a partial converse: For fixed g and N, if the minimal bridge number of K^n among genus g Heegaard surfaces is bounded by N for infinitely many n, then $\widehat{R}$ lies in some genus g Heegaard surface – assuming the exterior of the link $K \cup \partial\widehat{R}$ is hyperbolic and satisfies a certain homological condition.

Teragaito exhibits an infinite family of knots in S^3 for which $+4$ surgery yields a particular small Seifert fibered space. We use our work to show the surgery duals to Teragaito's knots have arbitrarily large bridge number with respect to any genus 2 Heegaard surface of that Seifert fibered space. This is in sharp contrast with what may occur for dual knots of non-integral surgeries. (Received August 22, 2011)

1074-57-242 **Ryan Blair** and **Maggy Tomova*** (maggy-tomova@uiowa.edu). *Width is not additive.*

The width of a knot, $w(K)$, is a knot invariant that was first defined by Gabai in his proof of property R. Since then the idea of width has had a number of important applications in 3-manifold topology including the solution to the knot complement problem and the solution to the recognition problem for S^3.

We develop a construction suggested by Scharlemann and Thompson to obtain an infinite family of pairs of knots K_α and K'_α so that $w(K_\alpha \# K'_\alpha) = max\{w(K_\alpha), w(K'_\alpha)\}$. This is the first known example of a pair of knots such that $w(K\#K') < w(K)+w(K')-2$ and it establishes that the lower bound $w(K\#K') \geq max\{w(K), w(K')\}$ obtained by Scharlemann and Schultens is best possible. Furthermore, the knots K_α provide an example of knots where the number of critical points for the knot in thin position is greater than the number of critical points for the knot in bridge position. (Received August 22, 2011)

1074-57-268 **Oliver T Dasbach*** (kasten@math.lsu.edu), Department of Mathematics, Louisiana State University, Baton Rouge, LA 70803, and **Cody Armond**. *Rogers-Ramanujan type identities coming from the colored Jones polynomial.*

We report on our work on the head and tail of the colored Jones polynomial. Various ways to compute the colored Jones polynomial for a given link give rise to combinatorial identities for those power series. (Received August 22, 2011)

1074-57-323 **Alissa S Crans*** (acrans@lmu.edu), Department of Mathematics, One LMU Drive, Suite 2700, Los Angeles, CA 90045, and **Allison Henrich** and **Sam Nelson**. *Generalized Alexander Polynomials for Virtual Knots.* Preliminary report.

We introduce a family of virtual knot and link invariants from the Alexander virtual biquandle, which generalize the classical Alexander polynomial and Sawolleck polynomial. (Received August 23, 2011)

60 ► Probability theory and stochastic processes

1074-60-184 **Nicholas F. Travers*** (ntravers@math.ucdavis.edu) and **James P. Crutchfield** (chaos@cse.ucdavis.edu). *The synchronization rate for exact ϵ-machines.*

ϵ-machines are minimal, unifilar hidden Markov models. An ϵ-machine is exactly synchronizable (or exact) if it has a synchronizing word w such that an observer is completely synchronized to the state S of the machine after observing the word w, $H[S|w] = 0$. We present an algorithm to calculate the synchronization rate for such machines, that is the rate at which an observer synchronizes to the internal state of the machine by observing the output symbols it generates. This result has important consequences for prediction. Since the next output symbol the machine generates is a function of the current state, better knowledge of the state tends to lead to better predictions of the output. And, more concretely, the synchronization rate α^* upper bounds the rate at which finite length approximations $h_\mu(L)$ converge to the machine's entropy rate h_μ. (Received August 20, 2011)

65 ► Numerical analysis

1074-65-9 **J. Ding*** (jiudin@gmail.com), Department of Mathematics, University of Southern Mississippi, Hattiesburg, MS 39406, and **N. Rhee**, Department of Mathematics and Statistics, University of Missouri atKansas City, Kansas City, MO 64110. *A piecewise linear maximum entropy method for calculating invariant measures of interval mappings.*

Let $S : [0, 1] \to [0, 1]$ be a nonsingular transformation such that the corresponding Frobenius-Perron operator $P_S : L^1(0, 1) \to L^1(0, 1)$ has a stationary density f^*. We propose a maximum entropy method based on piecewise linear functions for the numerical recovery of f^*. An advantage of this new approximation approach over the maximum entropy method based on polynomial basis functions is that the system of nonlinear equations can be solved efficiently because when we apply Newton's method, the Jacobian matrices are positive-definite and tri-diagonal. The numerical experiments show that the new maximum entropy method is more accurate than the Markov finite approximation method, which also uses piecewise linear functions, provided that the involved moments are known. (Received May 03, 2011)

1074-65-35 **Weimin Han*** (weimin-han@uiowa.edu), Department of Mathematics, University of Iowa, Iowa City, IA 52242. *Studies of a model in X-ray dark-field tomography.*

X-ray mammography is currently the most prevalent imaging modality for screening and diagnosis of breast cancers. However, its success is limited by the poor contrast between healthy and diseased tissues in the mammogram. A potentially prominent imaging modality is based on the significant difference of x-ray scattering behaviors between tumor and normal tissues. Driven by major practical needs for better x-ray imaging, exploration into contrast mechanisms other than attenuation has been active for decades, e.g., in terms of scattering, which is also known as dark-field tomography. In this talk, a theoretical study is provided for the x-ray dark-field tomography (XDT) assuming the spectral x-ray detection technology. For XDT, a generalized Fockker-Planck equation (GFPE) is employed to describe the light propagation for highly forward-peaked medium with small but sufficient amount of large-angle scattering. Properties of GFPE are studied, such as existence of a unique solution and positivity of the solution. XDT is then presented as an inverse parameter problem with GFPE as the forward model. Numerical methods are introduced to solve GFPE and the associated XDT. Simulation results are reported on several numerical examples for GFPE and for XDT. (Received July 17, 2011)

1074-65-75 **Michael L Parks*** (mlparks@sandia.gov), P.O. Box 5800, MS 1320, Albuuqerque, NM 17185. *A New approach to nonlocal advection.*

We describe a new approach to nonlocal, nonlinear advection in one dimension that extends the usual pointwise concepts to account for nonlocal contributions to the flux. The spatially nonlocal operators we consider do not involve derivatives, but instead utilize an integral formulation that, in an appropriate limit, reduce to the familiar local operators. We propose a nonlocal inviscid Burgers equation as a model with which to investigate nonlocal shock phenomena. We present numerical results comparing the behavior of the nonlocal Burgers formulation to the standard local case. The principal contribution of this work is to generalize the familiar local concepts of advection and flux to a nonlocal setting, thereby establishing the fundamental building blocks upon which to construct a theory of nonlocal shock phenomena consistent with the peridynamic framework. (Received August 09, 2011)

1074-65-193 **Yu-Min Chung*** (yumchung@indiana.edu), Rawles Hall, 831 3rd E. St., Bloomington, IN 47405. *On the computation of tracking initial condition.*

Under certain assumptions an inertial manifold is exponentially tracking. This means that the difference between the solution starting from a given initial condition and a particular "tracking" solution on the manifold decays at a prescribed exponential rate. In this work, an algorithm is implemented for the computation of the initial condition for the tracking solution. This algorithm is based on the fact that the inertial manifold and stable foliations are the graphs of Lipschitz functions which can be combined to form a contraction mapping whose fixed point is the tracking initial condition. The algorithm is applied to the Kuramoto-Sivashinsky equation. (Received August 21, 2011)

1074-65-219 **Yuri A. Melnikov*** (ymelniko@mtsu.edu), Dr. Yuri A. Melnikov, 1301 E. Main Street, Murfreesboro, TN 37132. *Green's functions-based approach to the representation of elementary functions by infinite products.*

It was in recent years that the idea emerged to compare alternative forms of Green's functions constructed with the aid of different methods for a variety of boundary-value problems posed for the two-dimensional Laplace equation. The comparison appeared really nontrivial. It ultimately gave birth to a score of infinite product representations of some trigonometric and hyperbolic functions. Some of those representations are simply alternatives to the classical forms, some others were derived, however, for functions whose infinite product representations are unavailable in literature. (Received August 22, 2011)

1074-65-273 **Mohamed Badawy*** (mbadawy@math.ku.edu) and **Erik S. Van Vleck**. *Perturbation theory for the approximation of stability spectra by QR methods for products of linear operators.*

In this talk, we go over the results that were obtained in a recent research project where we developed a perturbation analysis for the stability spectra (Lyapunov exponents and Sacker-Sell spectrum) for products of operators on a Hilbert space, based upon the discrete QR technique. Error bounds were obtained in both the integrally separated and non-integrally separated cases and for both real and complex valued operators. We illustrate our results by applying them to a linear parabolic partial differential equation in which the strength of the integral separation determines the sensitivity of the stability spectra. Integral separation is a natural analogue to having gaps between eigenvalues of a matrix in the finite dimensional case.

In deriving the error bounds on the stability spectra, the main idea is to formulate the mapping problem $x_{n+1} = A_n x_n$ as a zero finding problem. By design, the solution to the system of equations for this zero finding problem is the required sequence of unitary operators $\{Q_n\}$ resulting from repeated QR factorizations. Then, we apply the Newton-Kantorovich theorem, which not only gives us the necessary and sufficient conditions for the existence of a solution, but more importantly gives us bounds on the error in the Q_n's. (Received August 23, 2011)

1074-65-285 **Md Abdus Samad Bhuiyan*** (sb10ro@brocku.ca), 169 Devine Cr, Thorold, Ontario L2V5C1, Canada. *Effects of pressure stress work and viscous dissipation in mixed convection flow along a vertical flat plate in presence of heat generation.*

In this article,effects of pressure stress work and viscous dissipation in mixed convection flow along a vertical flat plate in presence of heat generation have been studied numerically. A viscous flow model is presented using boundary-layer theory comprising the momentum and energy conservation equations. The governing boundary-layer equations are transformed into non-dimensional form using appropriate reference quantities. The resulting coupled non-linear system of partial differential equations is solved numerically using the finite difference method along with Newton's linearization approximation. Attention has been focused on the evaluation of shear stress in terms of local skin friction and the rate of heat transfer in terms of local Nusselt number, velocity as well as temperature pro files. Numerical results have been shown graphically for some selected values of parameters set consisting of heat generation parameter, pressure work parameter and viscous dissipation parameter. (Received August 23, 2011)

68 ► Computer science

1074-68-147 **Derek Ratcliff*** (derek.ratcliff@gmail.com), Department of Computer Sciences, Georgia Southern University, Statesboro, GA 30460-7997, **Lixin Li** (lli@georgiasouthern.edu), Department of Computer Sciences, Georgia Southern University, Statesboro, GA 30460-7997, and **Robert Cook** (bobcook@georgiasouthern.edu), Department of Computer Sciences, Georgia Southern University, Statesboro, GA 30460-7997. *Measuring the Impact of Time Scale Choice on Spatiotemporal Interpolation using Parallel Computing.*

Spatiotemporal interpolation involves estimating the values of location-time pairs when the spatial or temporal coordinates, or both, are unknown. We study the effects that the choice of the time scale can have on the accuracy of interpolation results when using the IDW (Inverse Distance Weighting)-based method. We investigate through the comparison of four separate time scale choices by calculating and comparing error statistics for each case. Through these results, we demonstrate that the choice of time scale is non-trivial in spatiotemporal interpolation methods.

The error statistics are derived by applying leave-one-out cross-validation (LOOCV) to the interpolation results obtained for a data set of daily measurements of fine particulate matter at locations throughout the U.S. in 2009, using parallel programming techniques including POSIX threads and the Java concurrency APIs. Because the application of LOOCV to IDW interpolation is highly sequential, parallelizing the interpolations - in accordance with Amdahl's law - reduced the execution time in proportion to the number of processors available. This faster implementation allowed the examination of forty-five distinct IDW choices of number of neighbors and exponent weights at four separate time scales using LOOCV. (Received August 18, 2011)

1074-68-168 **Lixin Li*** (lli@georgiasouthern.edu), Department of Computer Sciences, Georgia Southern University, Statesboro, GA 30460-7997. *Time scale choices on shape function-based spatiotemporal interpolation method for evaluating population exposure to fine particulate matter pollution.*

This abstract investigates shape function-based spatiotemporal interpolation for the application of evaluating population exposure to ambient air pollution. The air pollutant of interest in this abstract is fine particulate matter $PM_{2.5}$. The choice of the time scale is investigated when applying the shape function-based method. It is found that the measurement scale of the time dimension has an impact on the interpolation results. Based upon the comparison between the accuracies of interpolation results, the most effective time scale out of four experimental ones was selected for performing the $PM_{2.5}$ interpolation. The abstract also evaluates the population exposure to the ambient air pollution of $PM_{2.5}$ at the census block group-level in the contiguous U.S. in 2009. The interpolated $PM_{2.5}$ has been linked to 2009 population data and the population with a risky $PM_{2.5}$ exposure has been estimated. The geographic distribution of the census blocks with a risky $PM_{2.5}$ exposure is visualized. This work is essential to understanding the associations between ambient air pollution exposure and population health outcomes. (Received August 19, 2011)

74 ► Mechanics of deformable solids

1074-74-174 **Reinhard Piltner*** (rpiltner@georgiasouthern.edu), Department of Mathematical Sciences, Georgia Southern University, Statesboro, GA 30460-8093, and **Lixin Li** (lli@georgiasouthern.edu), Department of Computer Sciences, Georgia Southern University, Statesboro, GA 30460-7997. *Mixed-enhanced quadrilateral finite elements with Wachspress-type functions.*

Simo and Rifai introduced the method of "enhanced strains" in 1990. Since then the method became quite popular to improve the performance of low order finite elements. The method has been used for both linear and non-linear problems by several researchers. Piltner and Taylor discussed an alternative to the original enhanced strain concept. In the alternative version of the enhanced strain method, a modified Hu-Washizu variational formulation is used. Stresses, strains, and enhanced strains are assumed in addition to the displacements. Previously, bilinear displacement shape functions assumed in a mapped bi-unit square have been used. For the current research Wachspress-type rational functions are utilized for the displacements. A special feature of the Wachspress rational functions is that they are linear on the finite element boundary between two neighboring corner nodes. Additionally, orthogonal stress and strain functions are used in the mixed formulation. This eliminates the problem of time consuming numerical inversions of matrices at the element level. The performance of the enhanced elements will be illustrated in a series of test examples. (Received August 19, 2011)

1074-74-254 **Pablo Seleson*** (seleson@ices.utexas.edu), ICES, The University of Texas at Austin, 1 University Station C0200, Austin, TX 78712. *Peridynamics as a Multiscale Material Model.*

Peridynamics is a nonlocal reformulation of classical continuum mechanics. As a nonlocal model, peridynamics possesses a length scale represented by its interaction range, or horizon. This motivates the use of peridynamics as a multiscale material model, in the sense that the peridynamic equation may exhibit different behavior depending on the choice of length scale. Peridynamics can be connected to other classical models at different scales, such as molecular dynamics and classical elasticity. For finite horizons, peridynamics can be cast as a continualization of molecular dynamics, allowing peridynamics to reproduce nonlocal behavior inherent to nonlocal discrete models, at a lower computational cost. The microscale behavior is lost at the classical elasticity scale, represented by a peridynamic model with very small horizon; in this limit, the peridynamic model becomes local. For multiscale purposes, we are interested in bridging different length scales; this talk will provide insights related to the coupling of local and nonlocal models in peridynamics. (Received August 22, 2011)

80 ► Classical thermodynamics, heat transfer

1074-80-276 **Florin Bobaru*** (fbobaru2@unl.edu), Mechanical and Materials Engineering, University of Nebraska-Lincoln, Lincoln, NE 68588-0526, and **Monchai Duangpanya**. *Peridynamic transient heat flow in bodies with evolving discontinuities.*

We construct a peridynamic theory of transient heat transfer and use it to simulate heat flow in bodies with insulated cracks that grow in time. The model can also be used for modeling of heat flow in bodies with (sharp)thermally heterogeneous inclusions, of flow through cracking porous media, or for heat/mass transfer in heterogeneous biological systems.

We start from the thermodynamic principles and derive the peridynamic model that does not contain spatial derivative of the temperature field. We solve problems of transient heat conduction in 1D bars and 2D rectangular plates with various nonlocal boundary conditions. The results show convergence to the analytical solutions of the classical model of heat transfer, in the limit of the peridynamic horizon going to zero. Interestingly, the numerical results in 1D indicate that the classical solution for transient heat transfer in 1D at a point and particular instant of time can be obtained as the intersection point of two m-convergence curves generated for any two different horizon sizes. In case the m-convergence curves do not intersect, then the classical solution is the limiting asymptote of the curves as $\delta \to 0$. (Received August 23, 2011)

81 ► Quantum theory

1074-81-145 **Sachin Gautam*** (gautam.s@husky.neu.edu), Rm 413, MC 4417, 2990 Broadway, New York, NY 10027. *Yangians and quantum loop algebras.*

For a semisimple Lie algebra $\mathfrak{g}$, the quantum loop algebra $U_\hbar(L\mathfrak{g})$ and the Yangian $Y_\hbar\mathfrak{g}$ are deformations of the loop algebra $\mathfrak{g}[z, z^{-1}]$ and the current algebra $\mathfrak{g}[u]$. These algebras arise naturally in the study of solvable lattice models in statistical mechanics. They have been extensively studied from a representation-theoretic point of view, and several features common to them have been observed. However, a precise explanation of these similarities has been missing so far. In this talk, I will explain how to construct a functor between the finite-dimensional representation categories of these algebras, which accounts for all the known similarities between them. This talk is based on a joint work with Valerio Toledano Laredo (arxiv:1012.3687). (Received August 18, 2011)

1074-81-210 **Alexander Shapiro*** (alexander.m.shapiro@gmail.com), 1625 Martin Luther King Jr, Berkeley, CA 94709. *Universal weight functions of quantum affine algebras.*

Universal weight function of a quantum affine algebra is a family of functions with values in its Borel subalgebra satisfying certain co-algebraic properties. The universal weight function happens to be a powerful tool to establish the algebraic Bethe ansatz which solves the eigenvalue problem for the set of commuting quantum integrals of motion. I am going to show how it can be constructed for the most simple $U_q(widehatsl_2)$-case. I will also state some results of joint work with S. Khoroshkin for the $U_qleft(A_2^{(2)}ight)$-case as for the first known case of quantum twisted affine algebra with the explicit formula for its universal weight function. (Received August 23, 2011)

92 ► Biology and other natural sciences

1074-92-11 **M. El-Doma*** (biomath2004@yahoo.com), Faculty of Mathematical Sciences, University, of Khartoum, P. O. Box: 321, Khartoum-Sudan, 11115 Khartoum, Khartoum, Sudan.
Stability Results for Size-structured Population Dynamics Models with Maturation.

In this paper, I will present some recent results about the stability of a general size-structured population dynamics model which at any time t divides the population into adults and juveniles, and there is an inflow of newborns from an external source. The model consist of a nonlinear partial differential equation with a non-local boundary condition and an initial condition as well and definitions for adults and juveniles. We determine the steady states and study their stability and then examine the effects of the inflow from an external source on the stability of the steady states as well as the other effects of juveniles on adults and vice versa. We also give examples that illustrate the stability results. (Received May 11, 2011)

1074-92-21 **Stephen J Willson*** (swillson@iastate.edu), Department of Mathematics, Iowa State University, Carver 411, Ames, IA 50011. *Reconstructing the parameters of a phylogenetic network from its tree-average distances.*

A phylogenetic tree is a tree whose leaves correspond to extant species. The tree depicts the course of evolutionary history as species mutate. Often each edge is weighted by a nonnegative real number measuring the amount of genetic change along the edge. The length of a path in the tree is found by adding the weights of edges along the path. The use of such trees is very common when inferring evolutionary history from DNA.

We generalize to rooted phylogenetic networks, which need not be trees and which include also events such as hybridization. A "tree-average distance" is defined which tells the average of the distances between the leaves in each displayed tree using these weights. Given a normal network N whose hybrid vertices have indegree 2 and with no vertices of outdegree higher than 2, we show how the weights may be reconstructed from the tree-average distances. One issue is the estimation of the fraction of the genome in a hybrid species that arises from the genome of each parent. Another is the reconstruction of N itself. (Received June 28, 2011)

1074-92-40 **Alan Veliz-Cuba***, aveliz-cuba2@unl.edu, and **Joseph Arthur**, **Laura Hochstetler**, **Victoria Klomps** and **Erikka Korpi**. *Dynamics 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 July 22, 2011)

1074-92-100 **Assieh Saadatpour*** (saadat@math.psu.edu), **Rui-Sheng Wang**, **Aijun Liao**, **Xin Liu**, **Thomas P Loughran**, **Istvan Albert** and **Reka Albert**. *Dynamical and structural analysis of a T cell survival network identifies novel candidate therapeutic targets for large granular lymphocyte leukemia.*

The blood cancer T cell large granular lymphocyte (T-LGL) leukemia is a chronic disease characterized by a clonal proliferation of cytotoxic T cells. As no curative therapy is yet known for this disease, identification of potential therapeutic targets is of utmost importance. In this study, we perform a comprehensive dynamical and structural analysis of a network model of this disease. By employing logical steady state analysis and a network reduction technique, we identify fixed points of the system, representing normal and T-LGL behavior, and analyze their basins of attraction using an asynchronous Boolean dynamic framework. This analysis identifies the T-LGL states of 54 components of the network, out of which 36 (67%) are corroborated by previous experimental evidence and the rest are novel predictions. We further test and validate one of these newly identified states experimentally. Our systematic perturbation analysis using dynamical and structural methods leads to the identification of 21 potential therapeutic targets, 57% of which are corroborated by experimental data. Overall, this study provides a bird's-eye-view of the avenues available for identification of therapeutic targets for similar diseases through perturbation of the underlying signal transduction network. (Received August 12, 2011)

1074-92-129 **Brigitte Tenhumberg*** (btenhumberg2@unl.edu), School of Biological Sciences, 412 Manter Hall, Lincoln, NE 68588. *Applications and Pitfalls of Structured Population Models in Ecology.*

Individuals within a population generally vary in their life history parameters. For instance, immature individuals do not reproduce and may have a higher risk of death than older individuals. As a consequence, the population dynamics depend on the relative proportion of individuals of different age, size or life history stages (e.g. egg, larvae, pupae, adults). If we are interested in the effect of natural and anthropogenic perturbations

that differentially affect different stages we need to use structured population models. In this paper I compare two different approaches to modeling stage structured populations: matrix models, the prevailing tool for analyzing the dynamics of plant and animal populations, as well as the relatively new integral projection modeling approach. I will use examples highlighting potential pitfalls concerning model structure and predicting the effect of perturbations. (Received August 17, 2011)

1074-92-201 **Devin R. Bickner***, Department of Mathematics, 396 Carver Hall, Iowa State University, Ames, IA 50014. *Binary Normal Network Space Is Connected.*

A rooted binary tree can be transformed into a different rooted binary tree on the same leaf set using a sequence of rooted subtree-pruning-regrafting (rSPR) operations. We show that a binary normal network can be transformed into any other binary normal network on the same leaf set using a set of three operations: adding an edge, deleting an edge, and rSPR. Because of this, binary normal network space is connected. We discuss some results about binary normal network space and some related results about normal networks. These results have applications to evolution and phylogenetic networks, especially hybridization events. (Received August 21, 2011)

1074-92-216 **Jonas Denissen*** (jonas.denissen@gmail.com), Hauptstr. 147, 10827 Berlin, Germany. *Classification of gene regulatory networks.*

A gene regulatory network (GRN) is a collection of functional interactions between genes in a cell. We will consider an asynchronous modeling approach introduced by R. Thomas. Depending on the state of the system each gene attains one of its finitely many discrete expression levels. Unfortunately, GRN modeling is limited by an incomplete knowledge about the system. The qualitative analysis of the GRN dynamics via the logic parameters helps us to reason about the model. Temporal logic can express biological properties of a GRN and thus limits the number of solutions. By introducing a new GRN encoding, we present a classification of the problem to determine the GRN dynamics. (Received August 23, 2011)

1074-92-230 **Valerie Hower*** (vhower@math.berkeley.edu), **Lior Pachter** and **Richard Starfield**. *Testing for fragment bias in high-throughput sequencing experiments.*

In most biological experiments, controlling the quality of data is fundamental to the reliability and reproducibility of the results. Modern sequencing experiments involve sampling millions of short fragments from a genome. In theory, the fragment start sites are Poisson distributed. As a result, the data from a sequencing experiment can be seen as coming from a two-dimensional spatial Poisson process. We present a statistical test based on this idea that measures the randomness in a collection of fragments. We then use this test to compare a variety of RNA-seq protocals. (Received August 22, 2011)

1074-92-252 **Christine E Heitsch*** (heitsch@math.gatech.edu), School of Mathematics, Georgia Institute of Technology, Atlanta, GA 30332. *Strings, Trees, and RNA Folding.*

An RNA molecule is a linear biochemical chain which folds into a three dimensional structure via a set of 2D base pairings known as a nested secondary structure. Reliably determining a secondary structure for large RNA molecules, such as the genomes of most viruses, is an important open problem in molecular biology. Using strings and (plane) trees as a combinatorial model of RNA folding, we give mathematical results which yield insights into the interaction of local and global constraints in RNA secondary structures and suggest new directions in understanding the structure of RNA viruses. (Received August 22, 2011)

1074-92-253 **Nicoleta E Tarfulea*** (ntarfule@purduecal.edu), Department of Mathematics, PUC, 2200 169th Street, Hammond, IN 46323. *A CTL-inclusive Mathematical Model for HIV Treatment with Time-varying Antiretroviral Therapy.*

We present a mathematical model to investigate theoretically and numerically the effect of immune effectors, such as the cytotoxic lymphocyte (CTL), in modeling HIV pathogenesis during primary infection. Additionally, by introducing drug therapy, we assess the effect of treatments consisting of a combination of several antiretroviral drugs. A periodic model of bang-bang type and a pharmacokinetic model are employed to estimate the drug efficacies. Nevertheless, even in the presence of drug therapy, ongoing viral replication can lead to the emergence of drug-resistant virus variances. Thus, by including two viral strains, wild-type and drug-resistant, we show that the inclusion of the CTL compartment produces a higher rebound for an individual's healthy helper T-cell compartment than does drug therapy alone. We investigate numerically how time-varying drug efficacy due to drug dosing regimen and/or suboptimal adherence affects the antiviral response and the emergence of drug resistance. Moreover, we characterize successful drugs or drug combination scenarios for both strains of virus. (Received August 22, 2011)

1074-92-259 **Robert Todd*** (rtodd@unomaha.edu) and **Tomas Helikar** (thelikar@unmc.edu). *Boolean Model of Budding Yeast Cell Cycle.* Preliminary report.

We start with Boolean rules and derive a model of the budding yeast cell cycle that incorporates stochasticity. We explore which aspects of the cell cycle are represented in the model. This model is substantially different from previous models in the way it incorporates randomness. Using some elementary theorems from semi-group theory we find some techniques that allow us to perform analytic calculations. We compare these with computer simulations. (Received August 22, 2011)

1074-92-270 **Susan N Coppersmith*** (snc@physics.wisc.edu), Department of Physics, University of Wisconsin-Madison, 1150 University Avenue, Madison, WI 53705. *Characterizing and Modeling the Microarchitecture of Mother-of-Pearl.*

Biominerals have attracted the attention of materials scientists, biologists, and mineralogists as well as physicists because of their remarkable mechanical properties and incompletely elucidated formation mechanisms. Nacre, or mother-of-pearl, is a layered biomineral composite that is widely studied because of its self-assembled, efficient and accurately ordered architecture results in remarkable resistance to fracture.

New experimental tools enable us to obtain new information about the organization and structure of the mineral tablets in nacre. Our experimental and theoretical investigations yield strong evidence that orientational ordering of these tablets is the result of dynamical self-organization.

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1074-92-298 **Carina Curto***, ccurto2@math.unl.edu. *Using distance geometry to encode memory patterns in neuronal networks.*

It is widely believed that networks of neurons in the brain encode memories via their patterns of synaptic connections. Given a list of memories, however, it is still an unsolved problem how to arrange the connectivity matrix of a network so that exactly these memories are encoded, while avoiding unwanted "spurious" states. In this talk, we will demonstrate how some classical concepts in distance geometry are surprisingly useful for tackling this problem. (Received August 23, 2011)

1074-92-299 **Vladimir Itskov*** (vitskov2@math.unl.edu). *From network structure to neural code topology.*

There are two complementary perspectives on what controls neural activity in sensory systems: receptive fields, and neural network dynamics. Receptive fields largely determine the representational function of a neuronal network, while network dynamics stem from the network structure. We propose a mathematical framework where the structure of neuronal networks can be related to combinatorial properties of receptive fields, and demonstrate how this can be used to relate network structure to topological invariants of represented stimuli. (Received August 23, 2011)

1074-92-305 **Brandilyn Stigler*** (bstigler@smu.com), 3200 Dyer Street, 209-C Clements Hall, Dallas, TX 75275. *Discrete-Continuous Reverse Engineering.*

The availability of large experimental data sets in systems biology has created a need for efficient algorithms to infer the structure of the underlying network. A common approach to reverse engineer the wiring diagram of a gene regulatory network is to approximate the network by a system of linear ordinary differential equations (ODE) and then to estimate the value of the constituent parameters. As the size of the network grows, parameter estimation becomes computationally very expensive. In this work, we present an inference algorithm that minimizes the parameter estimation problem. The algorithm consists of a two-step parameter estimation process. We first determine which parameters are zero using an algebraic method based on discrete dynamical systems. We then determine the strengths and signs of the nonzero parameters using particle swarm optimization. This hybrid approach combines the sensitivity of the discrete method with the specificity of the continuous method, without relying on simplifying assumptions such as network sparsity. We apply the algorithm to a data set we designed for the purpose of modeling and propose a more comprehensive model of an oxidative stress response network in yeast. (Received August 23, 2011)

1074-92-310 **Tomas Helikar*** (thelikar@mail.unomaha.edu), thelikar@unomaha.edu. *The Cell Collective: A collaborative modeling platform for biological processes.*

Despite decades of new discoveries in biomedical research, the overwhelming complexity of the cell has been a significant barrier to a fundamental understanding of how the cell works as a whole. The study of biochemical pathways as a whole in cells requires computer modeling of those pathways, but the complexity of the cell means that there is no one person or group that can model the cell in its entirety. The Cell Collective is a new platform designed to break this "chicken and egg" barrier to cell understanding, and allows the world-wide scientific community to create these models collectively (in the same way open-source software is created). Its intuitive interface is user-friendly to the biomedical research scientist in that no mathematical equations or computer code are required to build/use the models. Thus, The Cell Collective addresses one of the major issues with computational research – the inability of laboratory scientists to participate in the creation of the computational models. In addition, this platform allows scientists to simulate and analyze the models in real-time on the web, including the ability to simulate loss/gain of function and test many what-if scenarios in real time. (Received August 23, 2011)

93 ► Systems theory; control

1074-93-32 **Yan Wu***, yan@georgiasouthern.edu. *Controllability and Observability of Matrix Differential Algebraic Equations.*

Differential Algebraic Equations (DAEs) arise naturally as governing equations for systems in chemical, electrical, and mechanical engineering as well as biological and economic models. In this talk, we present some results on controllability and observability of a class of matrix DAEs. We first obtain a closed form representation for the solution of the matrix DAE. The solution is then used to derive necessary and sufficient conditions on the controllability and observability of time-varying matrix DAE systems. More straightforward and computationally efficient conditions on the controllability and observability of linear time-invariant matrix DAE systems are also obtained. (Received July 14, 2011)

1074-93-322 **Scott W. Hansen*** (shansen@iastate.edu), Iowa State University, Ames, IA 50011, and **Ahmet Ozkan Ozer** (ahmetozkanozer@gmail.com), 200 University Ave West, Waterloo, Ontario N2L3G1, Canada. *Exact controllability for multilayer Rao-Nakra beams and plates.*

We consider exact controllability of multilayer Rao-Nakra beams and plates. In the beam case we are able to obtain exact boundary controllability in the optimal time in the optimal spaces. In the case of "unbalanced" boundary conditions the control and/or observability spaces may be quotient spaces. For the plate system we consider locally distributed control in a neighborhood of the boundary. We obtain exact controllability if a list of technical conditions is satisfied. We describe domains for which these conditions hold. (Received August 23, 2011)

94 ► Information and communication, circuits

1074-94-20 **Nathan Axvig*** (axvignd10@vmi.edu), 431 Mallory Hall, Virginia Military Institute, Lexington, VA 24450. *Can pseudocodewords be used to increase communication rates?* Preliminary report.

The linear programming decoder of Feldman, Karger, and Wainwright operates by solving a linear programming relaxation of the maximum likelihood decoding problem. As such, one may assume that the output of the linear programming decoder is a vertex of the underlying polytope - such vertices are known as linear programming pseudocodewords. Although the set of codewords always lies within the set of pseudocodewords, it is often the case that the polytope contains non-integer vertices that do not correspond to codewords. When such a nontrivial pseudocodeword is output by the linear programming decoder, an error is declared and the decoder fails. In this talk, we explore how one might incorporate such nontrivial pseudocodewords into the encoding scheme so that meaningful information might be extracted from a received vector even when the output is a nontrivial pseudocodeword. (Received June 26, 2011)

1074-94-97 **Elizabeth A Weaver*** (eaweaver1s@uky.edu). *Dualizing Trellises for Linear Block Codes.* Preliminary report.

Tail-biting trellises are graphical representations for codes that have proved to be useful when decoding with the Viterbi algorithm. There are several known procedures to take the trellis for a code and use it to produce a trellis

representing the dual of the code. However, the resulting dual trellises do not always possess nice properties. We will examine when the different dualization processes result in isomorphic trellises and what characteristics of the original trellis are necessary to obtain a well-behaved dual trellis. (Received August 12, 2011)

1074-94-108 **Katherine Morrison*** (s-kmorri11@math.unl.edu), 203 Avery Hall, Lincoln, NE 68588. *Equivalence and Duality for Rank-Metric and Matrix Codes.*

We study self-dual rank-metric and matrix codes. Such codes often have a well-balanced trade-off between dimension and minimum distance. As we seek to enumerate and classify these self-dual codes, we also examine the notion of equivalence for rank-metric and matrix codes and use this to characterize the automorphism groups of these codes. Both rank-metric codes and matrix codes, also known as array codes or space-time codes over a finite field, have garnered significant attention because they can be "lifted" to form subspace codes. Subspace codes have become widely studied since Koetter and Kschischang first proposed their use in error correction for random linear network coding. (Received August 14, 2011)

1074-94-112 **Finley J. Freibert*** (fjfrei01@louisville.edu), 328 Natural Science Building, University of Louisville, Louisville, KY 40292, and **Jon-Lark Kim**, 328 Natural Science Building, University of Louisville, Louisville, KY 40292. *Optimal Distance Profiles of Binary Self-Dual Type II Codes.*

Self-dual codes have widespread relations to various areas such as combinatorial designs, unimodular lattices, and group theory. A self-dual code is called *doubly-even* or *Type II* if the weights of the codewords are divisible by 4. Let C be a binary $[n, k]$ code and let $C_0 = C$. A sequence of linear subcodes of C, $C_0 \supset C_1 \supset \cdots \supset C_{k-1}$ is called a *subcode chain*, where the dimension of C_i is $k - i$ for $i = 0, \ldots k - 1$. Let $d_i := d(C_i)$ be the minimum distance of C_i. Then the sequence $d_0 \leq d_1 \leq \cdots \leq d_{k-1}$ is called a *distance profile* of C. Luo, Vinck, and Chen (2010) have studied the optimal distance profiles of Reed-Solomon codes, Golay codes, the first order Reed-Muller codes, and the second order Reed-Muller codes. In this talk, we examine optimal distance profiles of all Type II codes of length 24, the extremal Type II codes of length 32, and some doubly-even self-orthogonal codes. (Received August 15, 2011)

1074-94-118 **Jay A. Wood*** (jay.wood@wmich.edu), Department of Mathematics, Western Michigan University, 1903 W. Michigan Ave., Kalamazoo, MI 49008-5248. *Relative One-Weight Codes.*

A linear code C is a *relative one-weight code* with respect to a linear subcode C_1 if every element of C that is not in C_1 has the same weight. This definition is due to Z. Liu and W. Chen (2010).

In this talk, a general construction of relative one-weight codes will be given that is valid over any finite Frobenius ring equipped with the homogeneous weight. As an application, certain linear two-weight codes will be described. (Received August 15, 2011)

1074-94-149 **Wittawat Kositwattanarerk*** (wkositw@clemson.edu), Department of Mathematical Sciences, Clemson University, Clemson, SC 29634, and **Gretchen L Matthews**. *On enumerating the pseudocodewords of a parity-check codes.*

Linear programming and message-passing iterative decoding algorithms are highly efficient and may correct errors even beyond the usual error-correcting capability of the code. However, they may output an illegitimate codeword called a pseudocodeword. In this talk, we demonstrate a one-to-one correspondence between pseudocodewords and integer points in a lifted fundamental cone. This allows enumeration of pseudocodewords via Barvinok's algorithm. In addition, irreducible pseudocodewords are found as a Hilbert basis for the lifted fundamental cone. (Received August 23, 2011)

1074-94-222 **Xiaoyu Liu*** (xiaoyu.liu@wright.edu), 3640 Colonel Glenn Highway, Dayton, OH 45435. *The Extension Theorem on Additive Codes over Finite Abelian Groups.*

The extension theorem of MacWilliams deals with the notion of equivalence of linear codes. It claims that if two linear codes over a finite Frobenius ring are isomorphic as abstract vector spaces via an isomorphism which preserves Hamming weight, then this isomorphism extends to a monomial transformation. In this paper, we study the extension theorem on additive codes over finite abelian groups. For an additive code over a finite abelian group, any coordinate of the code can be re-scaled by applying an automorphism on the group that preserves the weight defined on that group. Two additive codes are equivalent with respect to a certain weight if one can be obtained from the other by re-arranging and/or re-scaling its coordinates with respect to the weight. A weight is called extensible on some group if any weight preserving injective homomorphism extends to an automorphism on the group that still preserves the weight. Our main result of the paper proves that a weight defined on any finite abelian group admits the extension theorem if and only if it is extensible. We then study

extensible weights on some certain finite abelian groups, and finite abelian groups on which a certain type of weight is always extensible. (Received August 22, 2011)

1074-94-263 **Vishwambhar Rathi**, **Mattias Andersson**, **Ragnar Thobaben** and **Joerg Kliewer*** (jkliewer@nmsu.edu), Klipsch School of Electrical & Computer Engin, New Mexico State University, P.O. Box 30001, MSC 3-O, Las Cruces, NM 88003, and **Mikael Skoglund**.
Analysis and Design of Two Edge Type LDPC Codes for the BEC Wiretap Channel.

We consider transmission over a wiretap channel where both the main channel and the wiretapper's channel are Binary Erasure Channels (BEC). There are two performance criteria for a coding scheme used over a wiretap channel: reliability and secrecy. The reliability measure corresponds to the probability of decoding error for the intended receiver. This can be easily measured using density evolution recursions. However, it is more challenging to characterize secrecy, corresponding to the equivocation of the message for the wiretapper. Measson, Montanari, and Urbanke have shown how the equivocation can be measured for a broad range of standard LDPC ensembles for transmission over the BEC under the point-to-point setup. By generalizing this method to two edge type LDPC ensembles, we show how the equivocation for the wiretapper can be computed. We find that relatively simple constructions give very good secrecy performance and are close to the secrecy capacity. (Received August 22, 2011)

1074-94-275 **Kathryn A Haymaker*** (s-khaymak1@math.unl.edu). *Designing high-rate codes for flash memories with increased rewrites.* Preliminary report.

Binary write once memory (WOM) codes were introduced in the 1980s with the goal of storing information in cells that can be changed from a 0 to a 1, but whose cell levels can never decrease. The revival of interest in these codes is due to a similar asymmetric-write property that exists in models of flash memory storage. Flash cells may be reset to zero, but at a cost, thus prompting the need to maximize the number of writes before a reset. In this talk we will present a variation of the position modulation coding scheme that uses existing WOMs, and discuss the rates and rewrite capabilities of these codes. (Received August 23, 2011)

1074-94-293 **David Conti*** (david.conti@ucdconnect.ie). *Enumerating Trellis Pseudocodewords.*

A central paradigm in modern coding theory is to represent codes by special graphs from which powerful decoding algorithms can be derived. Trellises are among the most notable of such graph representations of codes, one main reason being that they benefit from a fruitful algebraic/combinatorial theory. Their decoding performance under important modern algorithms has been shown to depend on so called pseudocodewords (and their pseudoweights). In this talk we will take a stroll through trellises and their pseudocodewords, by presenting some fundamental questions and a motivating conjecture on a special trellis representing the Golay code. We will show how an algebraic framework can be developed to help us study and enumerate trellis pseudocodewords, bringing into the picture recurrence sequences and invariant theory. This is part of the Ph.D. research of D. Conti under the supervision of N. Boston. (Received August 23, 2011)

1074-94-295 **Nigel Boston*** (boston@math.wisc.edu), Department of Mathematics, University of Wisconsin, Madison, WI 53706. *Pseudocodewords and pseudoweights.*

The performance of iterative decoding algorithms may be affected by the existence of pseudocodewords of low pseudoweight. After reviewing this situation, we will give some new techniques that show the nonexistence of such pseudocodewords for certain important codes, in both the trellis and Tanner graph cases. Some of this depends on work by David Conti. (Received August 23, 2011)

1074-94-321 **Alexander Barg*** (abarg@umd.edu), **Arya Mazumdar** and **Gilles Zemor**.
Constructions of codes in permutations.

We study packings of the set of permutations with respect to the Kendall tau distance, i.e., the number of adjacent transpositions. We present several constructions of codes with large Kendall distance and simple decoding algorithms. The number of errors correctable by the codes covers a broad range of parameters. We also analyze asymptotic properties of the proposed constructions. (Received August 23, 2011)

1074-94-328 **Francis N. Castro** (franciscastr@gmail.com), Department of Mathematics, University of Puerto Rico, Rio Piedras, Box 70377, San Juan, PR 00936-8377, **Heeralal Janwa*** (heeralal.janwa@upr.edu), Department of Mathematics, University of Puerto Rico, Rio Piedras, Box 70377, San Juan, PR 00936-8377, **Gary L. Mullen** (mullen@math.psu.edu), Department of Mathematics, The Pennsylvania, State College, University Park, PA 16802,, and **Ivelisse M. Rubio** (iverubio@uprrp.edu), Department of Mathematics, UPR, University of Puerto Rico, Rio Piedras Campu, PO Box 70377, San Juan, PR 00936-8377.

e-Perfect Codes. Preliminary report.

We define and then discuss the existence of e-perfect codes over finite fields. (Received August 23, 2011)

03 ► Mathematical logic and foundations

1075-03-153 **Valentina Harizanov*** (harizanv@gwu.edu), Department of Mathematics, Washington, DC 20052. *Computability theoretic complexity of isomorphisms of countable structures.*

The study of computability in algebraic constructions started with Frőhlich and Shepherdson and with Rabin in the 1950s. They showed that when the original data are presented in a computable way, some constructions are algorithmic, while the others can be modified to become algorithmic, or cannot be done algorithmically in principle. We will focus on the complexity of isomorphisms of countable structures. Not all computable isomorphic structures are computably isomorphic or even limit computably isomorphic. Those that are computably isomorphic (limit computably isomorphic) are called computably categorical (limit computably categorical). We will characterize computable structures from some familiar classes of algebraic structures, which are computably categorical or limit computably categorical. The complexity of isomorphisms of structures that are not limit computably categorical can be further measured within the arithmetical or the hyperarithmetical hierarchy. (Received August 28, 2011)

05 ► Combinatorics

1075-05-3 **Igor Pak*** (pak@math.ucla.edu). *The future of bijections.*

Combinatorial bijections have been a staple of Enumerative Combinatorics for much of its recent history, leading to beautiful proofs, new results and interesting insights into the nature of combinatorial objects. In this talk, I will survey several ways in which the notion of bijection can be modified and adapted to prove new results on trees, partitions, and convex polytopes. Part of the talk is based on joint work with Matjaz Konvalinka. (Received August 31, 2011)

1075-05-164 **Briana Foster-Greenwood***, Department of Mathematics, University of North Texas, 1155 Union Circle #311430, Denton, TX 76203-5017. *Graded Hecke algebras and reflection length versus codimension.*

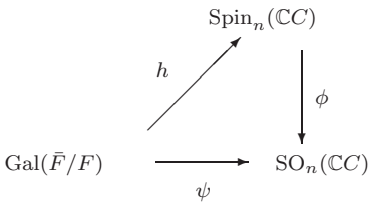
The geometry and combinatorics of finite reflection groups exhibits a rich and fruitful history. Modern investigations focus on deformation theory and Hochschild cohomology. Hochschild cohomology predicts deformations such as graded Hecke algebras and symplectic reflection algebras. We present new results on complex reflection groups comparing absolute reflection length and codimension of fixed point spaces. Analysis of the related posets (using algorithms developed in GAP, among other tools) allows an explicit description of cohomology. (Received August 29, 2011)

1075-05-190 **Christopher L Kocs*** (kocs@math.utah.edu). *Absolute Galois group computation.*

Given an odd integer n, there exists a surjective group homomorphism ϕ from $\mathrm{Spin}_n(\mathbb{C})$ onto $\mathrm{SO}_n(\mathbb{C})$, such that the following sequence is exact:

$$1 \longrightarrow <\text{-}1> \longrightarrow \mathrm{Spin}_n(\mathbb{C}) \xrightarrow{\phi} \mathrm{SO}_n(\mathbb{C}) \longrightarrow 1.$$

For any field extension F of $\mathbb{Q}_2$, we construct a homomorphism $\psi : \mathrm{Gal}(\bar{F}, F) \longrightarrow \mathrm{SO}_n(\mathbb{C})$, and we consider when there is homomorphism $h : \mathrm{Gal}(\bar{F}/F) \longrightarrow \mathrm{Spin}_n(\mathbb{C})$ such that the below diagram



commutes. This problem can be rephrased in terms of Clifford algebras and their corresponding quadratic forms. Ultimately, we are lead to compute the Hasse invariants, as a product of gauss sums, associated with these quadratic forms. (Received August 29, 2011)

1075-05-241 **Julianna Tymoczko*** (julianna-tymoczko@uiowa.edu), Department of Mathematics, 14 MacLean Hall, University of Iowa, Iowa City, IA 52245. *Generalizing Springer's representation to Hessenberg varieties.*

Hessenberg varieties are a natural family of subvarieties of the flag variety which share some important structure with the flag variety, including in some cases an action of the full torus. We will show that the cohomology of the Hessenberg varieties carries one of the permutation actions of the full flag variety. In a loose sense (which we will make precise), this representation generalizes Springer's representation. We will also discuss some amazing combinatorial conjectures and properties about these representations. Much of this work is joint with others, including Robert MacPherson (IAS) and Nicholas Teff (U of Iowa). (Received August 30, 2011)

08 ► General algebraic systems

1075-08-189 **Larissa Sbitneva*** (larissa@uaem.mx), Facultad de Ciencias, UAEM, Av. Universidad 1001, Col. Chamilpa, 62209 Cuernavaca, Morelos, Mexico. *Generalized Bruck loops related to non-gyrocommutative gyrogroups and generalized symmetric spaces as the underlying geometry.*

As is well known now the underlying geometry of gyrocommutative gyrogroups introduced by A. Ungar is just the geometry of symmetric spaces.

It turns out that the corresponding algebraic structure is just a non associative structure, the so-called Bruck loop, or, equivalently, a left Bol loop with the Bruck identity.

Some examples of non gyrocommutative gyrogroups by A. Ungar correspond to the case when the gyrocommutative property is not valid. In order to construct an example of non-Bruck loop, T. Fogel applied the algebraic construction of inclusion of loops into groups which is due to L. Sabinin.

Following this construction for the case of smooth loops we present an example of a Generalized Bruck loop realized as a section (transversal) on some reductive homogeneous space, thus it may be considered as an example of a non gyrocommutative gyrogroup.

The so called Generalized Bruck loops are the left Bol loops which are not Bruck loop.

Smooth left loops with the Bol and Generalized Bruck identities originated in the theory of generalized symmetric spaces.

We also present the infinitesimal characteristics for some class of smooth loops generalizing Bruck loops to be embedded into a Lie group. (Received August 29, 2011)

11 ► Number theory

1075-11-137 **Nolan Wallach*** (nwallach@ucsd.edu) and **Roberto Miatello** (miatello@famaf.unc.edu.ar). *Meromorphic continuation of Kloosterman-Selberg Zeta functions associated to non-compact finite volume rank 1 symmetric spaces.* Preliminary report.

Selberg introduced Derichlet series (now called Kloosterman-Selberg Zeta functions) associated with congruence subgroups of the modular group in order to use the Weil estimates on Kloosterman sums to prove his famous 3/16 Theorem. With a proper interpretation these "zeta functions" have generalizations to all non-compact, finite volume hyperbolic spaces (real, complex, quaternionic and octonian). These series are functions of a complex variable initially defined as a convergent series in a half plane. In this work we explain how to use our earlier work on analytic Poincaré series to prove a meromorphic continuation to the entire complex plane. This generalizes work of Cogdell, Piattetski-Shapiro, Sarnak (in the case of the reals) and partial results of Li (in the case of the complexes). We use our theory to analyse the meaning of the poles in the continuation. (Received August 26, 2011)

13 ► Commutative rings and algebras

1075-13-5 **Radwan M Alomary*** (radwan959@yahoo.com), Aligarh,muslim, University, departement of mathematic, Aligarh, IN 0091. *$*-$Lie ideals and generalized derivations on prime rings.* Preliminary report.

Let $(R,*)$ be a 2-torsion free $*-$prime ring with involution $*$ and center $Z(R)$. An additive mapping $*: R \longrightarrow R$ defined by $x \mapsto *(x)$ is called an involution if $*(*(x)) = x$ and $*(xy) = *(y)*(x)$ hold for all $x, y \in R$. A ring R with an involution $*$ is said to $*-$prime if $xRy = xR*(y) = 0$ implies that either $x = 0$ or $y = 0$. The set of symmetric and skew-symmetric elements of a $*-$ ring will be denoted by $S_*(R)$ i.e., $S_*(R) = \{x \in R \mid *(x) = \pm x\}$. An additive subgroup L of R is said to be a Lie ideal of R if $[L, R] \subseteq L$. A Lie ideal is said to be a $*-$Lie ideal if $*(L) = L$. If L is a Lie (resp. $*$-Lie) ideal of R, then L is called a square closed Lie (resp. $*$- Lie) ideal of R if $x^2 \in L$ for all $x \in L$. An additive mapping F: $R \longrightarrow R$ is called a generalized derivation on R if there exists a derivation d such that $F(xy) = F(x)y + xd(y)$ holds for all $x, y \in R$. In the present paper, we shall show that a $*-$Lie ideal L is central if R is a $*$-prime ring admits a generalized derivation F with associated derivation d commuting with $*$ satisfying certain differential identities in rings. (Received December 29, 2010)

1075-13-29 **Craig Huneke*** (huneke@math.ku.edu), Department of Mathematics, University of Kansas, Lawrence, KS 66045, and **Hailong Dao** and **Jay Schweig**. *Regularity bounds for graph ideals.* Preliminary report.

We discuss recent work of H. Dao, J. Schweig, and myself which gives bounds on the regularity of edge ideals of graphs which have linear presentation. (Received August 07, 2011)

1075-13-33 **Steven Dale Cutkosky*** (cutkoskys@missouri.edu), Dept. Math., Univ. Missouri, Columbia, MO 65211. *Asymptotic Growth of Saturated Powers and Epsilon Multiplicity.*

We study the growth of saturated powers of modules. In the case of an ideal I in a local ring $(R, \mathfrak{m})$, the saturation of I^k in R is $(I^k)^{\rm sat} = \cup_{n=1}^{\infty} I^k :_R \mathfrak{m}^n$. There are examples showing that the algebra of saturated powers of I, $\oplus_{k\geq 0}(I^k)^{\rm sat}$ is not a finitely generated R-algebra; As such, it cannot be expected that the "Hilbert function", giving the length of the R-module $(I^k)^{\rm sat}/I^k$, is very well behaved for large k. However, it can be shown that it is bounded above by a polynomial in k of degree d, where d is the dimension of R. We show that for quite general domains, there is a reasonable asymptotic behavior of this length. We extend this to the case of modules to show that the epsilon multiplicity, defined by Ulrich, Validashti and Kleiman, exists as a limit over very general domains. (Received August 11, 2011)

1075-13-34 **Hema Srinivasan*** (srinivasanh@missouri.edu), Department of Mathematics, University of Missouri, Columbia, MO 65211. *Betti Numbers of Affine Monomial Curves.*

We will discuss a conjecture on the periodicity of the betti numbers for the homogeneous coordinate ring of the affine monomial curves. We will prove this for the monomial curves associated to an arithmetic sequence which was the main motivation for the conjecture. In a joint work with P.Gimenez and I.Sengupta, we give an explicit construction of the minimal homogeneous resolution of $R/I_{\mathbf{m}}$ where R is a polynomial ring and $I_{\mathbf{m}}$ is the binomial ideal defining the monomial curve associated to an arithmetic sequence $\mathbf{m}$. In fact, we show that the Betti numbers for these depend only on the initial term m_0 of the arithmetic sequence modulo n the codimension of $R/I_{\mathbf{m}}$. (Received August 11, 2011)

1075-13-41 **Jen-Chieh Hsiao** and **Karl Schwede*** (schwede@math.psu.edu), Department of Mathematics, Penn State University, University Park, PA 16803, and **Wenliang Zhang**. *Cartier modules on toric varieties.*

In a recent paper, Blickle and Böckle, introduced the study of ideals of a ring fixed by a given p^{-e}-linear map. Unfortunately, there was a lack of examples. In this paper, we give a complete characterization of these ideals in the toric setting. Furthermore, we even generalize the question to triples, including a monomial ideal to a formal rational power.

By using a correspondence between p^{-e}-linear maps and divisors, we also find a multiplier-ideal-like characterization of these ideals utilizing a resolution of singularities. (Received August 25, 2011)

1075-13-45 **Christine Berkesch*** (cberkesc@math.duke.edu), Department of Mathematics, Duke University, Box 90320, Durham, NC 27708, and **Daniel Erman**, **Manoj Kummini** and **Steven V Sam**. *Tensor complexes.*

I will discuss two examples where free resolutions appear in algebraic geometry, in the study of determinantal varieties and the construction of resultants for multilinear systems of equations. I will then present a new construction for building multilinear free resolutions from tensors that simultaneously generalizes these examples.

Our construction has recently been implemented in Macaulay 2 by D. Erman, D. Eisenbud, G. Smith, and D. Stamate. (Received August 15, 2011)

1075-13-56 **Paul C Roberts*** (roberts@math.utah.edu), Department of Mathematics, University of Utah, 155 S 1400 E, Rm 233, Salt Lake City, UT 84112-0090. *Normal Non-Cohen-Macaulay Rings.*

In attempting to map a local ring to a Cohen-Macaulay ring, a natural step is to first map it to a normal domain. This reduces the problem to the case of normal domains and focuses attention on this case.

In fact, the number of actual examples of normal domains that are not Cohen-Macaulay is fairly limited, and techniques for finding maps to Cohen-Macaulay rings, particularly in mixed characteristic, often work in these cases for rather special reasons. In this talk we discuss these special properties and conditions needed to make these constructions work in general. (Received August 18, 2011)

1075-13-111 **Augustine B O'Keefe*** (aokeefe@tulane.edu) and **Huy Tài Hà** (tha@tulane.edu). *Cohen-Macaulay Toric Rings Arising from Finite Graphs.* Preliminary report.

Let G be a finite graph and $k[G]$ its associated toric ring. In this talk, we will show how the structure of G affects invariants related to the minimal free resolution of $k[G]$. In particular, using homological methods and the Auslander-Buchsbaum formula, we will determine when $k[G]$ is Cohen-Macaulay. (Received August 25, 2011)

1075-13-112 **Julia Porcino** and **Irena Swanson*** (iswanson@reed.edu), 3203 SE Woodstock Blvd, Portland, OR 97202. *2 x 2 permanental ideals of hypermatrices.*

We determine the prime ideals minimal over the ideal generated by classes of 2 x 2 permanents of n-dimensional hypermatrices. We give their description in terms of admitted sets. We contrast our work with that of Swanson and Taylor on ideals generated by 2 x 2 determinants of the same hypermatrix. (Received August 25, 2011)

1075-13-113 **Amelia Taylor*** (amelia.taylor@coloradocollege.edu), 14 E. Cache La Poudre St., Colorado Springs, CO 80903, and **Irena Swanson**. *Minimal primes of ideals arising from conditional independence statements.*

We describe (in a combinatorial way) the primary decomposition of a class of ideals arising in the context of conditional independence models. The ideals we consider generalize the ideals considered by Fink (2010) in a way distinct from that of Herzog, Hibi, Hreinsdottir, Kahle, and Rauh (2010). We give a combinatorial description of the the minimal components, along with the corresponding prime ideals(they turn out to be the same, although there are embedded primes) of these conditional independence ideals. Along the way we introduce an equivalence relation and recover some other interesting algebra and geometry results as a consequence of the development of the proof of our main result. (Received August 25, 2011)

1075-13-121 **Oana Veliche*** (o.veliche@neu.edu), Northeastern University, Department of Mathematics, 360 Huntington Avenue, Boston, MA 02115. *On the index of numerical semigroup rings of embedding dimension three.* Preliminary report.

The index of a local Gorenstein ring $(R, \mathfrak{m})$ was defined by Ding to be the minimum integer $n \geq 1$ for which the Auslander's delta invariant of $R/\mathfrak{m}^n$ is not zero. For a Gorenstein numerical semigroup ring of embedding dimension three, a complete formula of the index, in terms of the generators of the semigroup, is given. The talk will discuss the proof and some applications. (Received August 25, 2011)

1075-13-122 **Luchezar L Avramov**, **Melvin Hochster** and **Srikanth B Iyengar*** (iyengar@unl.edu), Department of Mathematics, University of Nebraska, Lincoln, NE 68506, and **Yongwei Yao**. *Homological invariants of modules over contracting endomorphisms.*

A celebrated result of Kunz states that if a local ring R of characteristic p is flat as module over itself via (some iterate of) the Frobenius endomorphism, then R must be regular. Recently, Avramov, Hochster, Yao, and I discovered that in fact the same conclusion holds even if there exists *some* non-zero finitely generated R-module M that has finite flat dimension as a module via an iterate of the Frobenius endomorphism. I will discuss this and related results. (Received August 25, 2011)

1075-13-136 **Jesse Beder**, **Jason McCullough*** (jmccullo@math.ucr.edu), **Luis Nunez-Betancourt**, **Alexandra Seceleanu**, **Bart Snapp** and **Branden Stone**. *Ideals with Large Projective Dimension and Stillman's Question.*

Let $R = K[x_1, \ldots, x_n]$ be a polynomial ring over a field K. Let $I = (f_1, \ldots, f_g)$ be a homogeneous ideal of R and set $d_i = degree f_i$. Stillman asked if there is a bound, dependent only $d_1, \ldots, d_g$. In this talk, we present a new construction of a family of ideals with large projective dimension relative to the degrees of the generators.

In particular, we define an ideal over an arbitrary field with three degree d generators with projective dimension larger that $\sqrt{d}^{\sqrt{d}}$. Thus any answer to Stillman's Question must be very large. (Received August 26, 2011)

1075-13-140 **Hirotachi Abo*** (abo@uidaho.edu), 300 Brink Hall, P.O. Box 441103, Moscow, ID 83844-1103, and **Chris Peterson** (peterson@math.colostate.edu), 101 Weber Building, Department of Mathematics, Colorado State University, Fort Collins, CO 80523-1874. *Implementation of Kumar's correspondence.*

In 1997, N.M. Kumar published a paper which introduced a new tool of use in the construction of algebraic vector bundles. Given a vector bundle on projective n-space, a well known theorem of Quillen-Suslin guarantees the existence of sections which generate the bundle on the complement of a hyperplane in projective n-space. Kumar used this fact to give a correspondence between vector bundles on projective n-space and vector bundles on projective $(n-1)$-space satisfying certain conditions. He then applied this correspondence to establish the existence of many, previously unknown, rank two bundles on projective fourspace in positive characteristic. The goal of this talk is to give an explicit homological description of Kumar's correspondence in a setting appropriate for implementation in a computer algebra system. (Received August 26, 2011)

1075-13-147 **Louiza Fouli*** (lfouli@math.nmsu.edu), Department of Mathematical Sciences, New Mexico State University, Las Cruces, NM 88003. *Minimal reductions and balanced ideals.* Preliminary report.

Let R be a Noetherian local ring and let I be an ideal. Recall that J is a reduction of I if $J \subset I$ and $I^{n+1} = JI^n$ for some non-negative integer n. An ideal I is called balanced if $J : I$ is independent of the minimal reduction J of I. We will discuss properties of balanced ideals as well as possible generalizations of this notion. (Received August 27, 2011)

1075-13-167 **Yi Zhang*** (zhang397@umn.edu), School of Mathematics, University of Minnesota, Minneapolis, MN 55455. *Graded F-modules and Local Cohomology.*

Let $R = k[x_1, \cdots, x_n]$ be a polynomial ring over a field k of characteristic $p > 0$, let $\mathfrak{m} = (x_1, \cdots, x_n)$ be the maximal ideal generated by the variables, let ${}^*E$ be the naturally graded injective hull of $R/\mathfrak{m}$ and let ${}^*E(n)$ be ${}^*E$ degree shifted downward by n. We introduce the notion of graded F-modules (as a refinement of the notion of F-modules) and show that if a graded F-module $\mathfrak{M}$ has zero-dimensional support, then $\mathfrak{M}$, as a graded R-module, is isomorphic to a direct sum of a (possibly infinite) number of copies of ${}^*E(n)$.

As a consequence, we show that if I is a homogeneous ideal of R, then as a naturally graded R-module, the local cohomology module $H^i_{\mathfrak{m}}(H^j_I(R))$ is isomorphic to ${}^*E(n)^c$, where c is a finite number. If char$k = 0$, this question is open. (Received August 29, 2011)

1075-13-168 **Vinh An Pham*** (vapnnc@mail.missouri.edu), University of Missouri-Columbia, Department of Mathematics, Columbia, MO 65201, and **Steven Dale Cutkosky** (cutkoskys@missouri.edu), University of Missouri-Columbia, Department of Mathematics, Columbia, MO 65201. *Valuation Semigroups of Two Dimensional Local Rings.*

In this paper, we give a construction of generating sequences in arbitrary regular local rings of dimension two. As a consequence, we obtain a simple necessary and sufficient condition for the pair of a semigroup and a field to be the semigroup and the residue field extension of a valuation dominating a complete regular ring local ring of dimension two. (Received August 29, 2011)

1075-13-176 **Sandra Spiroff*** (spiroff@olemiss.edu), Department of Mathematics, University of Mississippi, Hume Hall 305, P.O. Box 1848, University, MS 38677. *Expected Dimension versus Actual Dimension.* Preliminary report.

We compare the dimension of M $\otimes$ N with dim M + dim N - dim R when R is a graded complete intersection with isolated singularity, and M and N are finitely generated R-modules. In addition, we provide a Bézout-like result relating the degrees of M and N to the degrees of the torsion modules of M and N and the degree of R. A generalized version of Hochster's theta invariant plays a role. (Received August 29, 2011)

1075-13-180 **Lars Winther Christensen*** (lars.w.christensen@ttu.edu) and **Jesse Burke** (jburke@math.uni-bielefeld.de). *Building modules over a local ring from its singular locus.* Preliminary report.

Let R be a commutative noetherian local ring. In a paper from 2003, Schoutens proves that every finitely generated R-module can be built from the prime ideals in the singular locus Sing(R) by iteration of a few simple operations. It is known that the Krull dimension of a singular ring R provides an upper bound for the number

of iterations required to build any R-module. In the talk I will explain exactly how many iterations are required. (Received August 29, 2011)

1075-13-183 **Chris Peterson*** (peterson@math.colostate.edu), Department of Mathematics, Colorado State University, Fort Collins, CO 80523-1874. *Applications of Commutative Algebra to problems in Linear Algebra.*

This talk will focus on several applications of commutative algebra to problems in linear algebra. (Received August 29, 2011)

1075-13-186 **Karl Schwede** and **Kevin Tucker***, kftucker@princeton.edu, and **Wenliang Zhang**. *Test ideals via a single alteration and discreteness and rationality of F-jumping numbers.*

Suppose (X, Δ) is a log-$\mathbb{Q}$-Gorenstein pair. Recent work of M. Blickle and the first two authors gives a uniform description of the multiplier ideal $\mathcal{J}(X;\Delta)$ (in characteristic zero) and the test ideal $\tau(X;\Delta)$ (in characteristic $p > 0$) via regular alterations. While in general the alteration required depends heavily on Δ, for a fixed Cartier divisor D on X it is straightforward to find a single alteration (e.g. a log resolution) computing $\mathcal{J}(X;\Delta+\lambda D)$ for all $\lambda \geq 0$. In this paper, we show the analogous statement in positive characteristic: there exists a single regular alteration computing $\tau(X;\Delta+\lambda D)$ for all $\lambda \geq 0$. Along the way, we also prove the discreteness and rationality for the F-jumping numbers of $\tau(X;\Delta+\lambda D)$ for $\lambda \geq 0$ where the index of $K_X + \Delta$ is arbitrary (and may be divisible by the characteristic). (Received August 29, 2011)

1075-13-193 **Claudia Miller*** (clamille@syr.edu), Syracuse University, Syracuse, NY 13244-1150, and **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 under certain conditions. We give a slightly weaker version for all ideals (still over 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 first requires the Koszul homologies to satisfy Serre's condition for index at least half the dimension of the ring. The second requires them to satisfy a weakened sliding depth with a bound on the local number of generators of the ideal, yielding an extension of a result of Herzog, Vasconcelos, and Villareal. Each of these results is curious in that it appears to display the phenomenon that (in these cases) the heuristic from an old result of Hartshorne and Ogus for dual modules can be strengthened in the particular case of Koszul homology modules.

The key to all the results is a repeated careful analysis of a certain spectral sequence, thus also giving a new approach to the original sliding depth result. This is joint work with Hamid Rahmati and Janet Striuli. (Received August 29, 2011)

1075-13-194 **Mel Hochster** and **Wenliang Zhang*** (wlzhang@umich.edu). *Target elements and test ideals.*

An element r of a Noetherian domain R is called a target element if for every module-finite extension domain S of R, there is an R-linear map from S to R such that r is in the image. We will discuss some recent results on the ideal generated by target elements. This is a joint work with Mel Hochster. (Received August 29, 2011)

1075-13-217 **Sonja Petrovic*** (petrovic@stat.psu.edu). *Constructing Markov bases for hypergraphs.* Preliminary report.

Algebraic statistics as a branch of applied algebraic geometry offers many computational challenges. I will describe a family of algebraic models associated to hypergraphs. The talk will outline recent theoretical results for this family, but implementing the construction of the basic invariants remains open. (Received August 30, 2011)

1075-13-230 **Luis Núñez-Betancourt** (luisnub@umich.edu) and **Emily E. Witt*** (ewitt@umn.edu). *A generalization of Lyubeznik numbers.* Preliminary report.

Thanks to his proof, using D-module theory, that when R is an equicharacteristic regular local ring, the Bass numbers of all $H^i_I(R)$ are finite, Lyubeznik introduced a family of invariants now called *Lyubeznik numbers*. We give a generalization of Lyubeznik numbers using the fact that some local cohomology modules have finite length as D-modules (for certain rings of differential operators D). We also define Lyubeznik numbers for local rings of mixed characteristic. (Received August 30, 2011)

1075-13-235 **Daniel J Hernández*** (dhernan@umn.edu). *On F-purity at the F-pure threshold.*
Motivated by the (conjectured) relationship between F-purity and log canonical singularities, we examine the singularities of positive characteristic pairs at the F-pure threshold. In particular, we show that if R is an F-pure ring and $f \in R$, then the pair (R, f) must be F-pure at the F-pure threshold. We point out that the corresponding statement is known to be false for more general pairs, and even fails for certain pairs consisting of a monomial ideal of a polynomial ring over $\mathbb{F}_p$. We also show that certain strong conditions on the set of all F-pure thresholds, previously known to hold only when R is F-finite and regular, hold in the greatest possible generality. (Received August 30, 2011)

14 ► Algebraic geometry

1075-14-7 **Changlong Zhong*** (czhong@usc.edu), 3620 S Vermont Ave, KAP 108, Los Angeles, CA 90007. *Comparison of dualizing complexes.*
Algebraic geometers tried to generalize the Poincare duality by Grothendieck to more general cases, for instance, general (not necessarily smooth) schemes over algebraically closed fields, finite fields, local fields, or Dedekind domains. There are certain complexes constructed (or proved) by M. Spiess (for arithmetic surface), T. Moser (for p-torsion sheaves over finite fields of char p), K. Sato (for p-torsion sheaves over Dedekind domains) and T. Geisser (Bloch's cycle complex, for general cases) that define (Verdier or Poincare) dualities of constructible sheaves, acting as a dualizing complex. In this talk I will show that Bloch's complex is quasi-isomorphic all the other three understand essential conditions. (Received May 11, 2011)

1075-14-9 **Daniele Rosso*** (d_rosso@math.uchicago.edu). *Classic and mirabolic Robinson-Schensted-Knuth correspondence for partial flags.*
In this paper we first generalize to the case of partial flags a result proved both by Spaltenstein and by Steinberg that relates the relative position of two complete flags and the irreducible components of the flag variety in which they lie, using the Robinson-Schensted-Knuth correspondence. Then we use this result to generalize the mirabolic Robinson-Schensted-Knuth correspondence defined by Travkin, to the case of two partial flags and a line. This is a first step in an ongoing project that studies the convolution algebras of $\mathrm{GL}(V)$-invariant functions on varieties of two n-step flags and a line. (Received June 17, 2011)

1075-14-10 **Lubjana Beshaj*** (beshaj@oakland.edu), 368 SEB, Department of Mathematics and Statistics, Oakland University, Rochester, MI 48309-4485. *Theta functions with half-integer rational characteristics for genus three curves.* Preliminary report.
We will discuss some results for genus 3 non-hyperelliptic curves in terms of theta functions with half-integer characteristics. The case of hyperelliptic curves is well known and has been studied by many authors. We focus on superelliptic curves of genus 3 or higher. Our aim is to express the equation of the curve in terms of the theta-nulls. (Received September 01, 2011)

1075-14-11 **Valmira Hoxha*** (vhoxha@risat.org), 368 SEB, Department of Mathematics and Statistics, Oakland University, Rochester, MI 48309. *Equation of algebraic curves over their minimal field of definition.* Preliminary report.
We give algorithms to determine the equations of some genus $g > 2$ curves defined over the minimal field of definition. This extends work of Clebsch, Mestre, Shaska, and Cardona on genus 2. (Received August 31, 2011)

1075-14-12 **Tony Shaska*** (shaska@oakland.edu), 546 SEB, Department of Mathematics and Statistics, Rochester, MI 48309. *Vanishing theta nulls of algebraic curves.*
Let $\pi\colon \mathcal{X}_g \to \mathcal{X}_{g_0}$ be a m-sheeted covering of Riemann surfaces of genus g and g_0. The goal is to find properties that $\mathcal{X}_g$ (or rather, the Jacobian of $\mathcal{X}_g$) has, due to the existence of the covering π. This is an old problem that goes back to Riemann and Jacobi which is solved via the theta functions of the $\mathcal{X}_g$. Many other mathematicians have worked on the cases of small genus and small degree, most notably Frobenius, Prym, Königsberger, Rosenhein, Göpel, among others. The main goal of this talk is to discuss determining relations among theta-nulls in the non-hyperelliptic case for $g > 2$. The vanishing theta-nulls for hyperelliptic curves were studied by 19-th century mathematicians and are well understood. (Received June 26, 2011)

1075-14-17 **Haohao Wang*** (hwang@semo.edu), Math Department, MS6700, One University Plaza, Cape Girardeau, MO 63701. *μ-Basis of Rational Space Curves of Type (1; 1; d-2) and Minimal Generators for the Associated Rees Algebra.*

In this presentation, we will first investigate the moving surface ideal for rational quartic space curves via local cohomology computation. We will describe the minimal generators of this ideal according to the singularity of the quartic space curve. Then, we will generalize this method to the rational space curves whose μ-basis is of type $(1, 1, d-2)$, and provide an algorithm to find the minimal generators based solely on three μ-basis elements of the rational space curves. (Received July 04, 2011)

1075-14-36 **Max Lieblich*** (lieblich@uw.edu), **Davesh Maulik** and **Andrew Snowden**. *Finiteness of K3 surfaces and the Tate conjecture.*

Given a finite field k, the Tate conjecture holds for surfaces defined over each finite extension of k if and only if there are only finitely many K3 surfaces over each finite extension of k. (Received August 12, 2011)

1075-14-47 **Jonathan D. Hauenstein** (jhauenst@math.tamu.edu), Department of Mathematics, Texas A&M University, College Station, TX 77843-3368, **Nickolas Hein** (nhein@math.tamu.edu), Department of Mathematics, Texas A&M University, College Station, TX 77843-3368, **Christopher J. Hillar** (chillar@msri.org), Mathematical Sciences Research Institute, 17 Gauss Way, Berkeley, CA 94720-5070, **Abraham Martin del Campo*** (asanchez@math.tamu.edu), Department of Mathematics, Texas A&M University, College Station, TX 77843-3368, **Frank Sottile** (sottile@math.tamu.edu), Department of Mathematics, Texas A&M University, College Station, TX 77843-3368, and **Zach Teitler** (zteitler@math.boisestate.edu), Department of Mathematics, Boise State University, Boise, ID 83725. *The Monotone Secant Conjecture in the real Schubert calculus.*

The Monotone Secant Conjecture posits a rich class of polynomial systems, all of whose solutions are real. These systems come from the Schubert calculus on flag manifolds, and the Monotone Secant Conjecture is a compelling generalization of the Shapiro Conjecture for Grassmannians (Theorem of Mukhin, Tarasov, and Varchenko). We present the Monotone Secant Conjecture, explain the massive computation evidence in its favor, and discuss its relation to the Shapiro Conjecture. (Received August 15, 2011)

1075-14-48 **S. Casalaina-Martin*** (casa@math.colorado.edu), University of Colorado at Boulder, Department of Mathematics, Campus Box 395, Boulder, CO 80309. *The geometry of the ball quotient model of the moduli space of genus four curves.*

Many moduli spaces can be described as arithmetic quotients. The standard examples are moduli spaces of abelian varieties and of K3 surfaces. The Baily-Borel compactification of such spaces provides a projective completion with a number of good properties, although typically, it can be difficult to give a modular interpretation to the points in the boundary. Recently, S. Kondo has given an arithmetic (ball) quotient description of the moduli space of non-hyperelliptic genus four curves. In this talk I will discuss how the Baily-Borel compactification of this space can be compared with the Chow quotient for canonically embedded genus four curves; this provides a modular interpretation of the points in the boundary. Connections with the Hassett-Keel program will also be discussed. This is joint work with D. Jensen and R. Laza. (Received August 16, 2011)

1075-14-53 **Emanuele Macri*** (emanuele.macri@gmail.com), Department of Mathematics, The Ohio State University, 231 West 18th Avenue, Columbus, OH 43210. *Bogomolov-type inequalities in higher dimension.*

We will report on a joint work with A. Bayer, A. Bertram, and Y. Toda on a conjectural approach to the construction of Bridgeland stability conditions on the derived category of a higher dimensional variety. The main ingredient is a generalization to complexes of the classical Bogomolov-Gieseker inequality for sheaves. We will also discuss an application to the Fujita Conjecture for threefolds. (Received August 17, 2011)

1075-14-55 **Corey F Irving*** (cirving@math.tamu.edu). *Wachspress Varieties.*

We examine the algebraic geometry of Wachspress barycentric coordinates for polygons in the plane. These are functions on the polygon, one for each vertex, that express the point as a convex combination of the vertices. Wachspress's coordinates are rational barycentric coordinates of minimal degree. The algebraic relations among these Wachspress coordinates are discussed, which amounts to describing the (Wachspress) variety in $\mathbb{P}^{n-1}$ parametrized by these coordinates for an n-gon. (Received August 18, 2011)

1075-14-59 **Uli Walther*** (walther@math.purdue.edu). *Hypergeometric systems and singularities.* Preliminary report.

Hypergeometric systems, in the equivariant formulation, started on semigroup rings, then evolved to their torus invariant subschemes, and most recently moved on to binomial varieties. This talk will suggest some new grounds for growing D-modules of hypergeometric flavor from varieties. (Received August 19, 2011)

1075-14-65 **Maria Angelica Cueto*** (macueto@math.columbia.edu), Mathematics Department - Columbia University, Room 413, MC 4406, 2990 Broadway, New York, NY 10027. *Implicitization of surfaces via geometric tropicalization.*

In this talk we will discuss recent developments in tropical methods for implicitization of surfaces. This study was pioneered in the generic case by work of Sturmfels, Tevelev and Yu, and is based on the theory of geometric tropicalization, developed by Hacking, Keel and Tevelev. The latter hinges on computing the tropicalization of subvarieties of tori by analyzing the combinatorics of their boundary in a suitable (tropical) compactification. We enhance this theory by providing a formula for computing weights on tropical varieties, a key tool for tropical implicitization of generic surfaces. Finally, we will address the question of tropical implicitization for non-generic surfaces, closely related to the resolution of plane curve singularities. (arXiv:1105.0509) (Received August 21, 2011)

1075-14-75 **Hirotachi Abo*** (abo@uidaho.edu), 300 Brink Hall, Department of Mathematics, University of Idaho, Moscow, ID 83844, and **Maria Chiara Brambilla**, Dipartimento di Scienze Matematiche, Università Politecnica delle Marche, Via Brecce Bianche, 60131 Ancona, Italy. *New examples of defective secant varieties of Segre-Veronese varieties.*

In 1995, Alexander and Hirschowitz finished classifying all the defective secant varieties of Veronese varieties (i.e., the secant varieties of Veronese varieties that do not have the expected dimension). This work completed the Waring-type for polynomials, which had remained unsolved for some time. There are corresponding conjecturally complete list of defective cases for Segre varieties and for Grassmann varieties. Very recently, the defectivity of of Segre-Veronese varieties with two factors was systematically studied and it was suggested that secant varieties of such Segre-Veronese varieties are not defective modulo a fully described list of exceptions. The secant defectivity of more general Segre-Veronese varieties is less well-understood. In this talk, we explore higher secant varieties of Segre-Veronese varieties with three or more factors. The main goal of the talk is to prove the existence of defective secant varieties of three-factor and four-factor Segre-Veronese varieties embedded in a certain multi-degree. These defective secant varieties are previously unknown and are of importance in the classification of defective cases for Segre-Veronese varieties with three or more factors. (Received August 22, 2011)

1075-14-82 **Renzo Cavalieri*** (renzo@math.colostate.edu), Weber Building, Oval Drive, Fort Collins, CO 80524, and **Dustin Ross** (ross@math.colostate.edu), Weber building, Oval Drive, Fort Collins, CO 80523. *Open Orbifold GW Invariants.*

Open GW theory refers to the study of maps from Riemann Surfaces with boundary into a target manifold, where the boundary is constrained to map to a fixed Lagrangian submanifold. The physical theory of open strings gives several predictions for virtually enumerative invariants related to these kind of problems. I will discuss a computational (mathematical) framework to make sense of open GW invariants in the case of a toric orbifold target, and present some results, applications, speculations and work in progress in joint work with Andrea Brini (Geneva) and Dusty Ross (CSU). - Show quoted text - (Received August 22, 2011)

1075-14-89 **Mounir Nisse*** (nisse@math.tamu.edu), Department of Mathematics, Texas A&M University, College Station, TX 77843-3368, **Maurice Rojas** (rojas@math.tamu.edu), Department of Mathematics, Texas A&M University, College Station, TX 77843-3368, and **Korben Rusek** (krusek@math.tamu.edu), Department of Mathematics, Texas A&M University, College Station, 77843-3368. *Discriminant Coamoebas.*

The coamoeba of a complex algebraic variety is its image under the argument mapping. The main result of this paper is a complete description of the coamoebas of reduced A-discriminants in m variables for $m \geq 2$. This generalizes a description of Nilsson and Passare for $m = 2$ and gives an affirmative answer to a conjecture of Passare on this type of coamoeba. (Received August 23, 2011)

1075-14-90 **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, and 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 Nash blow-ups, lead to to a framework in which adjunction and inversion 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 August 23, 2011)

1075-14-95 **Luke Oeding*** (oeding@math.berkeley.edu), Department of Mathematics, University of California, Berkeley, 970 Evans Hall #3840, Berkeley, CA 94720, and **Daniel J Bates**. *Toward a salmon conjecture.*

Methods from numerical algebraic geometry are applied in combination with techniques from classical representation theory to show that the variety of 3x3x4-tensors of border rank 4 is cut out by polynomials of degree 6 and 9. Combined with results of Landsberg and Manivel, this furnishes a computational solution of an open problem in algebraic statistics, namely, the set-theoretic version of Allman's Salmon Conjecture for 4x4x4-tensors of border rank 4. A proof without numerical computation was given recently by Friedland and Gross. (Received August 23, 2011)

1075-14-102 **Steven Sperber*** (sperber@math.umn.edu). *Slopes for Hypergeometric Functions.* Preliminary report.

In joint work with Adolphson, we fix a prime p and consider some p-adic properties of classical hypergeometric functions having rational parameters. We realize the associated differential equation as arising from geometry. In particular the p-adic cohomology of a suitable family of varieties has the Gauss-Manin connection acting on it as well as a Frobenius map. We study the p-adic size of the eigenvalues of Frobenius. This is related to the p-adic growth of the solutions. (Received August 29, 2011)

1075-14-133 **Nero Budur*** (nbudur@nd.edu), Department of Mathematics, 255 Hurley Hall, Notre Dame, IN 46556. *Local zeta functions of hyperplane arrangements.*

We report on results on the local zeta function, Bernstein-Sato polynomials, and the monodromy conjecture for hyperplane arrangements. (Received August 26, 2011)

1075-14-134 **Dan Bates*** (bates@math.colostate.edu), **Chris Peterson**, **Andrew Sommese** and **Charles Wampler**. *A numerical-symbolic algorithm for computing the geometric genus of a curve.*

The common zero locus of a set of multivariate polynomials (with complex coefficients) determines an algebraic set. Any algebraic set can be decomposed into a union of irreducible components. Given a one dimensional irreducible component, i.e. a curve, it is useful to understand its invariants. The most important invariants of a curve are the degree, the arithmetic genus and the geometric genus. In this talk, I will describe a numerical algorithm to compute the geometric genus of any one-dimensional irreducible component of an algebraic set. This method uses heavily the algorithms of numerical algebraic geometry, so I will also provide a brief introduction to the necessary background in numerical algebraic geometry. (Received August 26, 2011)

1075-14-149 **Joseph Gubeladze*** (soso@sfsu.edu), Department of Mathematics, San Francisco State University, San Francisco, CA 94132. *Tautological part of K-theory of projective toric varieties.* Preliminary report.

For any functor F from (commutative) rings to abelian groups and a graded ring $R = R_0 \oplus R_1 \oplus \cdots$ the group $F(R_0)$ splits off from $F(R)$. The former can be viewed as the *tautological* part of the latter. Speaking geometrically, this is an essentially affine phenomenon. For a field k, how many copies of $K_0(k) = \mathbf{Z}$ can one split off from the Grothendieck group $K_0(X)$ of a projective toric variety X over k? Using Thomason's localization technique and the fundamental theorem of K-theory, one devises an iterative process for splitting off many copies of $K_0(k)$ from $K_0(X)$. The process unavoidably involves higher groups. It also goes through for all higher K-groups and general coefficient rings. Conjecturally, a K-group of a projective toric variety contains at least as many copies of the corresponding K-group of the base ring as the number of vertices of the underlying polytope, i. e., the number of standard affine toric charts. The case of a projective space shows that this is a sharp estimate. (Received August 27, 2011)

1075-14-150 **Ana-Maria Castravet*** (noni@alum.mit.edu), Department of Mathematics, OSU, 100 Math Tower, 231 West 18th Avenue, Columbus, OH 43210, and **Jenia Tevelev** (tevelev@math.umass.edu), Lederle Graduate Research Tower, University of Massachusetts, Amherst, MA 01003. *Rigid curves on $\overline{M}_{0,n}$ and arithmetic breaks.*

A result of Keel-McKernan states that a hypothetical counterexample to the F-conjecture must come from rigid curves on $\overline{M}_{0,n}$ that intersect the interior. In this talk I will discuss several ways of constructing such rigid

curves. In all our examples, an arithmetic argument shows that the classes of the rigid curves that we construct can be decomposed as sums of F-curves. (Received August 27, 2011)

1075-14-155 **Nickolas Hein*** (nhein@math.tamu.edu), Department of Mathematics, Texas A&M University, College Station, TX 77843, and **Jonathan Hauenstein**, **Abraham Martin del Campo** and **Frank Sottile**. *Eremenko-Gabrielov lower bounds beyond the Shapiro Conjecture.* Preliminary report.

The Shapiro Conjecture (now theorem of Muhkin, Tarasov, and Varchenko) asserts that an intersection of Schubert varieties has all points real if it is given by flags osculating a rational normal curve at real points. Eremenko and Gabrielov studied a weaker form of this, restricting to hypersurface Schubert varieties, but allowing the flags to osculate at complex points so that the intersection remains a real variety (that is, the osculating flags come in complex conjugate pairs). They proved a lower bound on the number of real points in such an intersection, independent of the number of complex conjugate pairs.

In this talk, I will give a brief exposition of this history and describe a computational project investigating these lower bounds of Eremenko-Gabrielov type for general intersections of Schubert varieties. We typically find lower bounds that depend upon the numbers of conjugate pairs of flags. Our data also suggest that the lower bounds of Eremenko and Gabrielov are not the best possible, and for some problems we observe interesting congruences modulo 4 for the numbers of real solutions. (Received August 30, 2011)

1075-14-184 **Dan Bates**, **David Eklund** and **Chris Peterson*** (peterson@math.colostate.edu), Department of Mathematics, Colorado State University, Fort Collins, CO 80523-1874. *Chern Numbers of Algebraic Varieties.*

This talk will describe a symbolic method and a numerical method for calculating intersection numbers of Chern Classes on an Algebraic Variety. (Received August 29, 2011)

1075-14-198 **Chris Swierczewski*** (cswiercz@amath.washington.edu), Department of Applied Mathematics, University of Washington, Guggenheim Hall #414, Box 352420, Seattle, WA 98195-2420. *Some Computational Problems Using Riemann Theta Functions in Sage.*

Computational tools in algebraic geometry are key to generating new conjectures and providing a means for solving problems in applications such as integrable systems and optimization. Recent features in Sage (http://www.sagemath.org) for performing computations with Riemann theta functions and algebraic curves provide steps towards solving a large class of these problems. In this talk we will discuss current and future developments in Sage for computational algebraic geometry and examine two applications in particular: generating genus two and three solutions to the Kadomstev–Petviashvili equation and computing determinantal representations of homogenous plane curves. (Received August 30, 2011)

1075-14-199 **Frank Sottile*** (sottile@math.tamu.edu), Department of Mathematics, Texas A&M University, College Station, TX 77843, and **Elisa Postinghel** and **Nelly Villamizar**. *Degenerations of Irrational Toric Varieties.*

A toric variety X_A is a subvariety of projective space P^n parameterized by a set A of $n+1$ monomials in Z^d. Kapranov, Sturmfels, and Zelevinsky showed that the set of all degenerations of X_A induced by the torus in P^n is parameterized by the toric variety of the secondary polytope of A, and in fact Hausdorff limits of torus translates are all toric degenerations.

A set of $n+1$ real numbers $A \subset R^d$ gives a map from the positive orthant $R^d_>$ to the n-simplex whose closure is an irrational toric variety. These likewise have torus translates by $R^n_>$ and the set of irrational toric degenerations is naturally identified with the secondary polytope of A. While these facts are immediate from the definitions, the main result of this talk, that all Hausdorff limits are toric degenerations, is not. The proof of this fact gives a new and completely elementary proof of the result of Kapranov, Sturmfels, and Zelevinsky. This is joint work with Elisa Postinghel and Nelly Villamizar of Oslo. (Received August 30, 2011)

1075-14-201 **Frank Sottile*** (sottile@math.tamu.edu), Department of Mathematics, Texas A&M University, College Station, TX 77843, and **Mikael Passare**. *Discriminant Coamoebas in Dimension 2 via Homology.*

Coamoebas of reduced A-discriminants arise when studying the convergence of Mellin-Barnes integrals for the solutions to the associated A-hypergeometric system. Nilsson and Passare described these coamoebas, in dimension 2, as topological chains in the 2-torus T^2 with piecewise-linear boundary. This boundary, with opposite orientation, is the boundary of a natural centrally symmetric zonotope in T^2, and they showed that the union of these two chains is a cycle equal to $\mathrm{vol}(A) \cdot [T^2]$, i.e., it covers T^2 $\mathrm{vol}(A)$-many times. Their proof could not be generalized to higher dimensions, and it gave no intuition about the multiplicity.

In this talk, which is joint work with Passare, we give a new, simpler, and elementary proof of these facts which identifies the multiplicity from the pushforward of a homology cycle in a torus T^A to T^2. The ingredients of this proof generalize to all dimensions, giving hope for a complete understanding of A-discriminant coamoebas. (Received August 30, 2011)

1075-14-202 **Mohamed Omar*** (momar@math.ucdavis.edu), Mathematics 253-37, Pasadena, CA 91125, and **Brian Osserman**. *Strong Nonnegativity and Sums of Squares.*

We introduce strong nonnegativity on real varieties, which has the property that a sum of squares is strongly nonnegative. We show that this algebraic property is equivalent to nonnegativity for nonsingular real varieties. Moreover, for singular varieties, we reprove and generalize obstructions of Gouveia and Netzer to the convergence of the theta body hierarchy of convex bodies approximating the convex hull of a real variety. (Received August 30, 2011)

1075-14-203 **Charlie R. Beil*** (cbeil@scgp.stonybrook.edu). *A geometric realization of noncommutative resolutions.*

I will discuss how a noncommutative resolution of a singularity can be understood geometrically as the limit where the exceptional locus of a commutative resolution is shrunk to ramified point-like spheres. (Received August 30, 2011)

1075-14-206 **Lev A Borisov** and **R Paul Horja*** (horja@math.okstate.edu). *The better behaved version of the GKZ hypergeometric system.*

A version of the generalized hypergeometric system introduced by Gelfand, Kapranov and Zelevinski will be defined. In this definition, the underlying lattice is replaced by a finitely generated abelian group. Moreover, the rank of the better behaved GKZ hypergeometric system is always the expected one. (Received August 30, 2011)

1075-14-207 **Adrian Clingher**, **Charles F. Doran*** (charles.doran@ualberta.ca), **Jacob Lewis** and **Andrey Novoseltsev**. *K3 Modular Parametrization and Calabi-Yau Threefold Variations.* Preliminary report.

We'll begin by recalling the Doran-Morgan classification of "mirror-compatible" integral variations of Hodge structure over the thrice punctured sphere. These fall into fourteen equivalence classes, according to shared real structures. Thirteen of these readily admit geometric realization via the Batyrev-Borisov mirror construction. The "14th case" has long proved elusive, despite strong hints coming from analysis of GKZ-hypergeometric systems and Hodge theory. A geometric solution will be presented, blending K3 surface fibrations, modular parametrizations, and a detailed analysis of (singular) toric hypersurfaces and complete intersections. (Received August 30, 2011)

1075-14-234 **Shaowei Lin*** (shaowei@math.berkeley.edu), 970 Evans Hall #3840, Berkeley, CA 94720. *Computing integral asymptotics using toric blow-ups of ideals.*

Integrals of the form $Z(N) = \int_\Omega e^{-Nf(\omega)}\varphi(\omega)\,d\omega$ occur frequently in applications such as machine learning and computational biology. We are often interested in the asymptotics $Z(N) \approx CN^{-\lambda}(\log N)^{\theta-1}$ as N grows large. If f has a unique mimimum point where the Hessian is positive definite, the asymptotic coefficients C, λ and θ are given by the classical Laplace approximation. In this talk, we study the case $f = g \circ h$ where $g : \mathbb{R}^k \to \mathbb{R}$ satisfies the above Laplace condition at the origin and $h : \mathbb{R}^d \to \mathbb{R}^k$ is a polynomial map. Using Newton polyhedra and toric resolutions, we introduce a notion of nondegeneracy for ideals and derive formulas for the asymptotic coefficients when the ideal $\langle h_1(\omega), \ldots, h_k(\omega)\rangle$ is nondegenerate. (Received August 30, 2011)

16 ► Associative rings and algebras

1075-16-27 **James J Zhang*** (zhang@math.washington.edu), Department of Mathematics, Box 354350, University of Washington, Seattle, WA 98195. *Lie-Delta-algebras.*

A Lie-delta-algebra is both a Lie algebra and a coalgebra. The universal enveloping algebra of a Lie-delta-algebra is viewed as a coalgebraic deformation of the usual universal enveloping algebra of a Lie algebra. This new enveloping algebra provides some interesting examples of noncommutative and noncocommutative Hopf algebras. (Received August 06, 2011)

1075-16-64 **Linhong Wang*** (lwang@selu.edu), Department of Mathematics, SLU 10687, Southeastern Louisiana University, Hammond, LA 70402. *Nonsplit module extensions over the algebra of one-sided inverse of $k[x]$.* Preliminary report.

Let R be the associative algebra over a field k generated by two elements x and y, with y being the left inverse of x. The algebra R has been studied by Jacobson, Irving, Gerritzen, Bavula, and others. The known results include the prime and maximal spectra of R, the system of simple R-modules, a faithful representation of R by an algebra of shift operators on an infinite-dimensional vector space, etc. In this work, we give an explicit classification of nonsplit extensions of simple R-modules by examining the short exact sequence of the form $0 \longrightarrow U \longrightarrow E \longrightarrow V \longrightarrow 0$, where U and V are simple R-modules. (Received August 20, 2011)

1075-16-73 **M. Susan Montgomery*** (smontgom@math.usc.edu), Dept of Mathematics, KAP 108, University of Southern California, 3620 S. Vermont Ave, Los Angeles, CA 90089-2532. *Values of Frobenius-Schur indicators for Hopf algebras.*

Let H be a semisimple Hopf algebra over $\mathbb{C}$, and let V be an irreducible representation of H. It is known that for each integer n, $1 \leq n \leq Exp(H)$, one may define $\nu_n(V)$, the n^{th} Frobenius-Schur indicator of V, generalizing the facts for representations of finite groups. The indicators are gauge invariants, that is they are invariants for the monoidal category of representations of H, and they have had nice applications.

Although for the group algebra $\mathbb{C}G$ of a finite group G, all values of $\nu_n(V)$ are integers, this is not true in general for Hopf algebras, although they must lie in the ring of n^{th} cyclotomic integers (Kashina-Sommerhäuser-Zhu). It was hoped that for nice examples, such as $H = D(G)$, the Drinfel'd double, the values of $\nu_n(V)$ would still be integers.

Recently this has been shown to be true for $D(G)$ in many examples. We discuss these positive results, due variously to Marc Keilberg 2010, Rebecca Courter 2011, and in new work of the speaker joint with Mio Iovanov and Geoff Mason. (Received August 22, 2011)

1075-16-84 **Birge Huisgen-Zimmermann*** (birge@math.ucsb.edu) and **Kenneth R. Goodearl** (goodearl@math.ucsb.edu). *Irreducible components of module varieties.*

Let $Rep(A, \mathbf{d})$ be the classical affine variety parametrizing the modules of dimension vector $\mathbf{d}$ over a finite dimensional algebra A. We expand existing methods for exploring the irreducible components of these varieties, addressing both their geometry (e.g., rationality and normality) and the generic behavior of the modules they represent. In particular, we show that birational invariants and generic behavior of the components are determined by closed subvarieties of far smaller dimension. (Received August 23, 2011)

1075-16-107 **Eric M Friedlander** and **Julia Pevtsova***, Dept. of Mathematics, University of Washington, Seattle, WA. *p-Lie algebras and modules of constant Jordan type.*

This talk will serve as a brief overview of some aspects of representation theory and cohomology of Lie algebras in characteristic p developed since the 80's. The starting point is the calculation of the cohomology algebra of a p-Lie algebra due to Friedlander-Parshall and Andersen-Jantzen and the subsequent development of the theory of support varieties. I'll discuss how that led to the introduction of modules of constant Jordan type in a joint work with Carlson and Friedlander and describe how modules of constant Jordan type give rise to vector bundles on projective varieties. (Received August 25, 2011)

1075-16-115 **David Hill**, Dept. of Mathematics, University of Virginia, Charlottesville, VA 22904, **Jonathan Kujawa***, Math. Department, University of Oklahoma, Norman, OK 73019, and **Joshua Sussan**, Vivatsgasse 7, Bonn, Germany. *Representations of the Degenerate Affine Hecke-Clifford Superalgebra.*

If we wish to study the representation theory of the symmetric group it is often natural to study the degenerate affine Hecke algebra. We then obtains the symmetric group theory as a consequence of the more general setting. If we wishes to study the spin representations of the symmetric group, then in an entirely analogous way we are led to study the degenerate affine Hecke-Clifford superalgebra.

We define an analogue of the Schur-type functor of Arakawa and Suzuki. In their work the functor is between category O of the Lie algebra gl(n) and the degenerate affine Hecke algebra. In ours it is between category O of the Lie superalgebra q(n) and the degenerate affine Sergeev superalgebra. Using this functor we provide a description of the integral simple modules for this algebra in terms of the type B analogue of Zelevinsky's multisegments. (Received August 25, 2011)

1075-16-132 **Christopher R. Nowlin*** (cnowlin@math.ucsb.edu), cnowlin@math.ucsb.edu.
Torus-invariant prime spectrum of an affine quantum nilpotent Lie algebra.

Fix a nonzero scalar q and an integer $n \geq 2$. We introduce an algebra $\mathbf{X}_{n,q}$, which has a quotient isomorphic to a distinguished subalgebra of the FRT-algebra of type D_n. Let W represent the affine Weyl group of type $\tilde{A}_3$; we show there is a particular element $\hat{w} \in W$ for which $\mathbf{X}_{2,q}$ is isomorphic to a cocycle twist of the corresponding De Concini-Kac-Procesi algebra, denoted $U_q^{\hat{w}}$. Under standard mild hypotheses, there is an algebraic torus H which acts by algebra automorphisms on $\mathbf{X}_{2,q}$ with respect to which $\mathbf{X}_{2,q}$ is a Cauchon-Goodearl-Letzter extension. We will proceed to show that the subset of the prime spectrum of $\mathbf{X}_{2,q}$ invariant under the induced action of H is isomorphic as a partially ordered set to the Bruhat order interval $\{w \in W : w \leq \hat{w}\}$. This agrees with a theorem of Yakimov's for De Concini-Kac-Procesi algebras of finite type. (Received September 01, 2011)

1075-16-146 **Thomas Cassidy*** (tcassidy@bucknell.edu) and **Christopher Lee Phan**. *Quotients of Koszul algebras and 2-d-determined algebras.* Preliminary report.

Vatne and Green & Marcos have independently studied the Koszul-like homological properties of graded algebras that have defining relations in degree 2 and in exactly one other degree. I will contrast these two approaches, and answer two questions posed by Green & Marcos. I will also discuss the use of Grobner bases in this context. (Received August 27, 2011)

1075-16-148 **Boris Adamczewski** and **Jason P Bell***, Department of Mathematics, 8888 University Dr., Burnaby, BC V5A 1S6, Canada. *The noetherian property for naive blow-up algebras in positive characteristic.*

In this paper, we consider naive blow-up algebras, introduced by Keeler, Rogalski, and Stafford, in positive characteristic. These algebras are produced using geometric data, and it was shown by Keeler, Rogalski, and Stafford showed that to such rings, one can associate an irreducible projective variety X, a point $x \in X$, and an automorphism σ of X and that such an algebra is noetherian precisely when the orbit of x under X is infinite and has the property that every infinite subset is dense (i.e., the orbit is critically dense). In characteristic 0, Bell, Ghioca, and Tucker showed that if some infinite subset of the orbit fails to be dense, then there is some iterate τ of σ such that that the orbit of x under τ fails to be dense. In characteristic $p > 0$, additional pathologies are known to occur. We show that for many classes of varieties, if some infinite subset of the orbit fails to be dense, then there is a large "automatic" subset S of $\mathbb{Z}$ (generated by a finite-state automaton) such that the subset of the orbit corresponding to S is not Zariski dense. This show how this allows one to effectively determine whether a naive blow-up algebra in positive characteristic is noetherian. (Received August 27, 2011)

1075-16-171 **Daniel Rogalski*** (drogalsk@math.ucsd.edu) and **Jason Bell** (jpb@sfu.ca). *$\mathbb{Z}$-graded simple algebras.*

Let k be of a field of characteristic 0. The first Weyl algebra $A_1(k) = k\langle x, y\rangle/(yx - xy - 1)$ is $\mathbb{Z}$-graded with $\deg(x) = 1, \deg(y) = -1$, and is a simple ring of GK-dimension 2. Sierra has studied its category of graded modules and shown how to find all $\mathbb{Z}$-graded algebras with an equivalent graded module category. Smith has also shown how the geometry of this example is related to a certain stack. Our goal is to study more general classes of $\mathbb{Z}$-graded simple rings to find more examples which may have interesting algebraic and geometric properties. Specifically, we study the structure of $\mathbb{Z}$-graded simple algebras A with graded quotient ring Q such that Q_0 is a field with $\operatorname{trdeg}(Q_0) = \operatorname{GK} A - 1$. As a special case, we can classify all $\mathbb{Z}$-graded simple rings of GK-dimension 2. (Received August 29, 2011)

1075-16-187 **Gregory P Muller***, gmuller@lsu.edu. *Skein algebras of marked surfaces.*

Given a surface with boundary and a collection of marked points on the boundary, consider all curves in the surface which end at the marked points. One may define the (Kauffman) skein algebra generated by these curves; this generalizes the 'unmarked' skein algebra where only loops are considered. When there are enough marked points for the surface to admit a triangulation, then remarkable new phenomena appear, including a connection to the 'cluster algebra' of the marked surface. Joint with Peter Samuelson. (Received August 29, 2011)

1075-16-220 **Karel Casteels*** (casteels@math.ucsb.edu), Dept. of Mathematics, UC, Santa Barbara, Santa Barbara, CA 93106. *Quantum Matrices by Paths.* Preliminary report.

We show how the canonical generators of the algebra of mxn quantum matrices may be interpreted as a weighted sum of paths in a certain directed graph (weighted by elements of the mxn quantum torus). We'll show how this viewpoint allows for simplified/new/intuitive proofs of known results concerning the prime spectrum of the algebra. (Received August 30, 2011)

1075-16-222 **Anne V. Shepler*** (ashepler@unt.edu), University of North Texas, Mathematics Department, Denton, TX 76203-5017, and **Sarah Witherspoon**. *Lie Orbifold Algebras and Graded Hecke Algebras.*

Graded Hecke algebras, symplectic reflection algebras, and rational Cherednik algebras are all noncommutative deformations of skew group algebras. What singles them out among all possible deformations? What related deformations deserve similar attention? For example, how might one complete the following analogy: Weyl algebras are to symplectic reflection algebras as universal enveloping algebras are to what? In this talk, we introduce a general class of deformations which completes this analogy and includes all the algebras mentioned above as special cases. We also discuss Poincare-Birkhoff-Witt properties. (Received August 30, 2011)

17 ► Nonassociative rings and algebras

1075-17-40 **Bogdan Ion*** (bion@pitt.edu), Department of Mathematics, Pittsburgh, PA 15260. *Generalized exponents.*

I will discuss and illustrate a conjectural positive formula for generalized exponents (and more generally q-multiplicities) that is suggested by my work on the generalized exponents of small representations. (Received August 14, 2011)

1075-17-74 **Garrett Johnson*** (gwjohns3@ncsu.edu) and **Chris Nowlin**. *The FRT-Construction via Quantum Affine Algebras and Smash Products.*

For every element w in the Weyl group of a simple Lie algebra $\mathfrak{g}$, De Concini, Kac, and Procesi defined a subalgebra $\mathcal{U}_q^w$ of the quantized universal enveloping algebra $\mathcal{U}_q(\mathfrak{g})$. The algebra $\mathcal{U}_q^w$ is a deformation of the universal enveloping algebra $\mathcal{U}(\mathfrak{n}_+ \cap w.\mathfrak{n}_-)$. We construct smash products of certain finite-type De Concini-Kac-Procesi algebras to obtain ones of affine type; we have analogous constructions in types A_n and D_n. We show that the multiplication in the affine type De Concini-Kac-Procesi algebras arising from this smash product construction can be twisted by a cocycle to produce certain subalgebras related to the corresponding Faddeev-Reshetikhin-Takhtajan bialgebras. (Received August 22, 2011)

1075-17-124 **Eric M. Friedlander*** (eric@math.northwestern.edu), Department of Mathematics, University of Southern California, 3620 S. Vermont Ave, Los Angeles, CA 90089, and **Julia Pevtsova**. *Elementary subalgebras of Lie algebras.* Preliminary report.

We initiate the investigation of the projective variety $\mathbb{E}_r(\mathfrak{g})$ of elementary subalgebras of dimension r of a p-restricted Lie algebra $\mathfrak{g}$ for some positive integer r. We view $\mathbb{E}_r(\mathfrak{g})$ as an interesting geometric structure attached to $\mathfrak{g}$, one whose computation and analysis appears accessible in many cases. We consider special classes of (p-restricted) representations of $\mathfrak{g}$ which lead to algebraic vector bundles on $\mathbb{E}_r(\mathfrak{g})$. (Received August 25, 2011)

1075-17-159 **Young Jo Kwak*** (kwaky@colorado.edu), 491 Geneva Street 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 Aut(G(4)) is computed and Aut(G(n)) = (Z/2Z) x Sn for all n $>$ 4 by the combinatorial basis. (Received August 28, 2011)

1075-17-245 **G. P. Wene*** (gpwene2011@hotmail.com), Department of Mathematics, The University of Texs at San Antonio, One UTSA Circle, San Antonio, TX 78249-0624. *Third Power Association In Finite semifields.* Preliminary report.

R. H. Oehmke [1] showed that a finite semifield S", charateristic not two, that satisfies the reflexive relation

(a,b,a)= 0

for all a,b in S", is commutative. The flexible relation implies the association of cubes:

(a,a,a) = 0

for all elements a of the semifield. We ask "Does the association of cubes imply commutativity in finite semifields not of charaterictic two?" Our preliminary result suggest a positive answer to this question. [1] R. H. Oehmke, On finite division rings, Proc. Amer. Math. Soc. 79 (1980), 174-176. (Received August 31, 2011)

18 ► Category theory; homological algebra

1075-18-106 **Leonardo Traversoni*** (ltd@xanum.uam.mx), Av San Rafael Atlixco 186, 09340 Mexico City, DF, Mexico. *On the Geometry of a Moving Singularity.*

We present an idea on how to represent an expanding contracting moving singularity. We show everyday examples of bubbles in water created by cavitation which indeed are a singularity in the continuum (water) and how to matematically explain high bursts of energy release known as sonoluminiscence (Received August 25, 2011)

1075-18-143 **Krzysztof K Putyra*** (putyra@math.columbia.edu), Room 509, MC 4406, 2990 Broadway, New York, NY 10027, and **Jozef H Przytycki** (przytyck@gwu.edu). *Homology of distributive lattices: Mayer-Vietoris type sequences.* Preliminary report.

Consider a set X with a family of right self-distributive operations $\star_1, \dots, \star_k$. We say that X is a *multishelf*, if operations $\star_i$ are mutually right distributive: $(x \star_i y) \star_j z = (x \star_j z) \star_i (y \star_j z)$. Moreover, if they are idempotent, we call X a *multispindle*. A classical example is a distributive lattice with four operations: join, meet and projections on first or second argument.

For a multishelf we can define a *multi-term chain complex* $C_n(X) = \mathbb{Z}X^{n+1}$ with a differential $\partial = a_1\partial^{\star_1} + \dots + a_k\partial^{\star_k}$ (each summand $\partial^{\star_i}$ is determined by $\star_i$) and compute its homology groups. In case of a lattice, this chain complex splits into three parts: $C(X) = C(\{t\}) \oplus \mathcal{F}^0(X,t) \oplus C/\mathcal{F}^0(X,t)$, where $t \in X$. Although two of them are easy to compute, for the third we need some technics.

In my talk I will define a few Mayer-Vietoris type sequences, most of which split. The most important one gives a decomposition of homology $H(L,t) = H(L \wedge y, t \wedge y) \oplus H(L \vee y, t \vee y)$ for any lattice L. This reduces the problem of computing homology of a finite distributive lattice to a two-element Boolean algebra B_1. (Received August 27, 2011)

1075-18-221 **Yuri Berest*** (berest@math.cornell.edu), Department of Mathematics, Cornell University, Ithaca, NY 14853-4201, and **Ajay Ramadoss** (ajay.ramadoss@math.ethz.ch), Department Mathematik, ETH Zurich, 8092 Zurich, Switzerland. *Derived Representation Schemes and Cyclic Homology.*

The classical representation scheme $\mathrm{Rep}_n(A)$, parametrizing the n-dimensional representations of an associative algebra A, defines a contravariant functor on the category of associative algebras. A natural problem is to describe the higher derived functors of Rep_n in the sense of non-abelian homological algebra. I. Ciocan-Fontanine and M. Kapranov (2001) proposed a geometric solution to this problem as part of a general program of deriving Quot schemes and other moduli spaces in algebraic geometry. In this talk, I will present a different algebraic construction of the derived functors of Rep_n arising from noncommutative geometry and discuss some interesting implications. (Received August 30, 2011)

20 ► Group theory and generalizations

1075-20-16 **Miodrag Cristian Iovanov*** (yovanov@gmail.com) and **Susan Montgomery**. *On the integrality of the Frobenius Schur indicators of tensor categories.* Preliminary report.

Frobenius-Schur indicators of a group are classical invariants associated to a group, and have a concrete interpretation; they are always integers. These were generalized to (semisimple) Hopf algebras by Montgomery and Linchenko, and then further tensor categories by Mason, Ng, Schauenburg. These indicators proved to be powerful gauge invariants of such categories; for example, the FS indicators can distinguish between nonequivalent tensor categories (representation theories) with the same same fusion rules (character ring). In general, these invarians can be non-integers, but all known examples of quasi-triangular Hopf algebras or symmetric tensor categories have integer FS indicators. This lead several people to raise the question if (and conjecture that) the FS-indicators of symmetric fusion categories categories are integers. We address this problem and present results due to several researchers (S.Montgomery, R.Ng, G.Mason) and the author. We focus on the Drinfeld double of a group, and provide number theoretical equivalent conditions for the FS indicators to be integers, and also some classes of groups for which the indicators of D(G) are ingegers. Using computer algebra, we also find a large interesting class of counterexamples to this conjecture. (Received July 03, 2011)

1075-20-63 **Daniel K. Nakano*** (nakano@math.uga.edu), Department of Mathematics, University of Georgia, Athens, GA 30602. *Support varieties and cohomology for modules over quantum groups.*

In this talk I will explain how to compute the support varieties of all the irreducible modules for the small quantum group $u_\zeta(\mathfrak{g})$, where $\mathfrak{g}$ is a simple, complex Lie algebra and ζ is an ℓ-th root of unity larger than the Coxeter number. This calculation employs the prior calculations and techniques of Ostrik and of Nakano–Parshall–Vella, in addition to deep results involving the validity of the Lusztig character formula and the positivity of parabolic Kazhdan-Lusztig polynomials for the affine Weyl group. Analogous results are provided for the first Frobenius kernel G_1 of a reductive algebraic group scheme G defined over the prime field $\mathbb{F}_p$.

If time permits, I will discuss the problem of realizing coordinate algebras of nilpotent orbit closures in regards to the cohomology for quantum groups. These results encompass joint work with Christopher Drupieski, Brian Parshall (support varieties) and Zongzhu Lin (realizing rings of regular functions). (Received August 20, 2011)

1075-20-85 **Delaram Kahrobaei*** (dkahrobaei@gc.cuny.edu), PhD Program in Computer Science, CUNY Graduate Center, 365 Fifth Avenue, New York, NY 10016. *A decade of using non-commutative groups in cryptography.*

In this talk I will give a quick survey of development of new cryptosystems using non-commutative groups, their weaknesses, strengths as well as new directions. I will also describe a couple of my new results. (Received August 23, 2011)

1075-20-91 **Tom Edgar***, Mathematics Department, Pacific Lutheran University, Tacoma, WA 98406. *Conjectural Normal Form for Elements of Coxeter Groups.* Preliminary report.

Let (W, S) be an arbitrary Coxeter system. We discuss a notion of closure in the root system (or reflections). We also introduce other types of subsets of roots and describe their relationship to closed subsets. We describe some conjectures, posed by Dyer, inspired by closure in the root system. Finally, we provide an application of these conjectures, which would lead to a normal form for elements of the Coxeter group; moreover, we mention the cases where these conjectures are known to be true. (Received August 23, 2011)

1075-20-103 **J. Matthew Douglass*** (douglass@unt.edu). *Equivariant K-theory of generalized Hecke algebras and affine Hecke algebras.* Preliminary report.

Kazhdan and Lusztig construct an explicit isomorphism between the extended, affine Hecke algebra $\mathcal{H}$ of a reductive, complex, algebraic group G, and the equivariant K-theory of the Steinberg variety of G. In this talk I will report on progress toward constructing a "relative" version of the Kazhdan-Lusztig isomorphism. In the relative setting, the Steinberg variety of G is replaced by a generalized Steinberg variety that depends on a pair of parabolic subgroups, and $\mathcal{H}$ is replaced by a bimodule for two suitably chosen subalgebras. The special case when both parabolics are equal G itself has been described by Ostrik.

The construction I will describe may be viewed as the affine analog of a construction of Curtis, who gave a"relative" version of Lusztig's explicit isomorphism between the group algebra of the Weyl group of G and its Iwahori-Hecke algebra. In both situations, Kazhdan-Lusztig bases play a key role. (Received August 24, 2011)

1075-20-142 **Lucas Sabalka*** (sabalka@math.binghamton.edu) and **Dmytro Savchuk** (dsavchuk@math.binghamton.edu). *On restricting free factors in relatively free groups.*

Let G be a free, free nilpotent, or free metabelian group, and let $A = \{a_1, ..., a_n\}$ be a basis for G. We will show that if S is a subset of a basis for G which may be expressed without the element a_n then, with small restrictions on the size of S, the set S is a subset of a basis for the relatively free group on $A - \{a_n\}$. (Received August 27, 2011)

1075-20-162 **Robert W Bell*** (rbell@math.msu.edu), Dept. of Mathematics, Michigan State University, East Lansing, MI 48824. *On hyperbolic surface subgroups in right-angled Artin groups.* Preliminary report.

We present recent work towards understanding the following problem: characterize those graphs which define right-angled Artin groups which contain the fundamental group of a closed hyperbolic surface. (Received August 29, 2011)

1075-20-172 **Josh Barnard*** (jbarnard@jaguar1.usouthal.edu), Department of Mathematics & Statistics, University of South Alabama, Mobile, AL 36688. *Bounding surface actions on Gromov-hyperbolic spaces.*

We seek bounds on translation distance for an isometric action with positive injectivity radius of a surface group on a Gromov-hyperbolic space. In previous work we showed that there is always some point moved a

bounded distance by a standard generating set. Here we prove a somewhat stronger result with applications to determining, in the case that the space is a 3-manifold, whether the action is geometrically and topologically tame. (Received August 29, 2011)

1075-20-181 **Liudmila Sabinina*** (liudmila@uaem.mx), Facultad de Ciencias, UAEM, av.Universidad 1001, 62209 Cuernavaca, Morelos, Mexico. *Graphs and non-associative algebra.* Preliminary report.

Recently the construction of Cayley graphs for loops by Sabidussi and Mwambene was applied to study some problems in Graph Theory. We would like to develop further this direction. (Received August 29, 2011)

1075-20-196 **Benjamin F Jones*** (jonesbe@uwstout.edu). *Enumerating strata in an enhanced quiver variety.* Preliminary report.

We discuss the enumeration of strata in the enhanced quiver variety introduced in a paper of Pramod Achar, Anthony Henderson, and the author. The enumeration is motivated by a conjecture that relates the normality of enhanced nilpotent orbit closures to a purely combinatorial problem involving the strata. We will discuss the extent to which the aforementioned conjecture has been verified using an optimized parallel algorithm implemented in the mathematical software system Sage. (Received August 30, 2011)

1075-20-212 **Dmytro M Savchuk*** (dmytro.savchuk@gmail.com), Department of Mathematical Sciences, Binghamton University, Binghamton, NY 13902. *Schreier graphs and Schreier dynamical system of the action of Thompson's group F on the Cantor set.*

We construct Schreier graphs of the actions of Thompson's group F on the orbits of all points of the Cantor set with respect to the standard generating set $\{x_0, x_1\}$, classify them up to isomorphism, and study the corresponding Schreier dynamical system.

Schreier dynamical systems were studied in the context of ergodic theory by Zimmer, Vershik and Grigorchuk. Sometimes it is possible to show that given an action of a group on a set, the Schreier dynamical system constructed from just one orbit, can recover the original action of the group on the whole set. We show that this is exactly the case for the action of F on the Cantor set.

Finally, we show that all constructed Schreier graphs are amenable. (Received August 30, 2011)

1075-20-216 **Kim Ruane*** (kim.ruane@tufts.edu), **Adam Piggott** and **Genevieve Walsh**. *Automorphisms of Graph Products.* Preliminary report.

We discuss ongoing joint work with G. Walsh and A. Piggott concerning the outer automorphism group of a graph product of finitely generated abelian groups. In particular, we will focus on results concerning the outer automorphism group of a universal right-angled Coxeter group. (Received August 30, 2011)

1075-20-223 **Ross Geoghegan*** (ross@math.binghamton.edu). *The fundamental group at infinity.*

The fundamental group at infinity is an interesting invariant of finitely presented (f.p.) groups. In this talk I will review the "semistability problem" and its homological analog. I will mainly emphasize recent progress in joint work with Craig Guilbault. Theorem: Let G be a one-ended f.p. group having an element of infinite order; then G is either simply connected at infinity, or is virtually a surface group, or the fundamental group at infinity of G is not pro-monomorphic. The method of proof, when combined with previous work of Guilbault, has topological consequences. For example, let M be a closed aspherical n-manifold whose universal cover is not $\mathbb{R}^n$ (e.g. via Davis); any non-trivial covering transformation in G has mapping torus homeomorphic to $\mathbb{R}^n \times S^1$ (while, of course, the mapping torus of the trivial element is $M \times S^1$.) (Received August 30, 2011)

1075-20-242 **Chris Hruska*** (chruska@uwm.edu), Department of Mathematical Sciences, University of Wisconsin–Milwaukee, PO Box 413, Milwaukee, WI 53201-0413, and **Kim Ruane**. *Local topology of boundaries for CAT(0) spaces with isolated flats.* Preliminary report.

We study CAT(0) spaces with isolated flats and the local topology of the boundary at infinity (with the visual topology). In particular, we prove a theorem characterizing exactly when the boundary is locally connected.

This theorem extends Swarup's result that the boundary of every hyperbolic group is locally connected. We illustrate our theorem with an example of a one-ended CAT(0) group with isolated flats whose boundary is not locally connected. We also prove that every group acting properly and cocompactly on a CAT(0) space with isolated flats is semistable at infinity.

Related results were obtained by Bowditch in the setting of relatively hyperbolic groups. However, the "relative boundary" studied by Bowditch is different from the CAT(0) boundary studied here. In particular, Bowditch's results on the relative boundary do not restrict the local connectivity of the CAT(0) boundary. (Received August 30, 2011)

22 ► Topological groups, Lie groups

1075-22-22 **Gordan Savin***, Department of Mathematics, 155 S 1400 E, Salt Lake City, UT 84112, and **Wee teck Gan**. *Weil representation and Hecke algebras for metaplectic groups.*

The Iwahori Hecke algebra was described, in terms of generators and relations, in a beautiful work of Iwahori and Matsumoto over 40 years ago. This algebra has a canonical basis consisting of characteristic functions of double cosets. This important feature is missing when one wants to extend the theory to non-linear groups. In this work we show how the Weil representation can be used to construct a basis of the algebra for the metaplectic group i.e. two fold central extension of the symplectic group. (Received July 29, 2011)

1075-22-32 **Dan Barbasch*** (dmb14@cornell.edu) and **Peter Trapa**. *Unipotent representations for Sp(p,q) and O*(n).* Preliminary report.

In this work, joint with P. Trapa, we establish the unitarity of the unipotent representations in the sense of Arthur or Adams-Barbasch-Vogan for the real forms Sp(p,q) and O*(n). Unipotent representations are conjectured to be the building blocks of the unitary fual of a reductive real group. The techniques rely heavily on properties of the associated cycle or asymptotic support of an admissible module. (Received August 09, 2011)

1075-22-98 **Dubi Kelmer*** (dubi.kelmer@bc.edu), Department of Mathematics, 301 Carney Hall, Boston College, Chestnut Hill, MA 02467. *On the spectrum and length spectrum of hyperbolic manifolds.*

There is a very close relation between the Laplace spectrum and the lengths of closed geodesics on negatively curved manifolds. For hyperbolic surfaces the Laplace spectrum and the length spectrum determine each other. However, in higher dimensions the connection is more mysterious. In this talk I will describe new results showing that the Laplace spectrum of a compact hyperbolic manifold is determined by its length spectrum, and discuss how much of the length spectrum is actually needed in order to recover the Laplace spectrum. (Received August 26, 2011)

1075-22-120 **Moshe Adrian*** (madrian@math.utah.edu). *On the local Langlands correspondence of DeBacker/Reeder for unramified U(3).*

In recent work, Stephen DeBacker and Mark Reeder have described a conjectural local Langlands correspondence for depth zero supercuspidal L-packets of unramified p-adic groups. In joint (in progress) work with Joshua Lansky, we verify that their correspondence is correct for unramified U(3). In this talk, I will describe their correspondence for unramified U(3) in detail, illuminating much of the general theory along the way. (Received August 25, 2011)

1075-22-156 **Amber Russell*** (arussell@math.lsu.edu). *Graham's Variety and Perverse Sheaves on the Nilpotent Cone.* Preliminary report.

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. For type A, a key tool is a description of the affine paving of Springer fibers given by Tymoczko that lends itself nicely to understanding the fibers of Graham's map. (Received August 28, 2011)

1075-22-160 **B Trahan***, trahan@math.utah.edu. *Lefschetz Functors for the Metaplectic Group.* Preliminary report.

In a recent paper, Ciubotaru and Trapa defined a family of exact functors carrying spherical Harish-Chandra modules for real classical linear algebraic groups to representations of a certain algebra called the graded affine Hecke algebra. Representations of this algebra can then be translated, thanks to results of Lusztig, Barbasch, and Moy, into representations of a p-adic group of the same type as the original real group. The result, in effect, is a Lefschetz functor for real classical linear algebraic groups; it also embeds the spherical unitary dual for the real group into the spherical unitary dual for the p-adic group. This talk discusses an analagous functor for genuine representations of the real and p-adic metaplectic groups. (Received August 28, 2011)

1075-22-161 **Mark Colarusso*** (colamark@isu.edu), Department of Mathematics, Physical Sciences 318, P.O. Box 8085, Idaho State University, Pocatello, ID 83209, and **Sam Evens**. *K-orbits on the flag variety and the geometry of Gelfand-Zeitlin fibers.*

In two 2006 papers, Kostant and Wallach constructed a complexified Gelfand-Zeitlin integrable system for the Lie algebra $\mathfrak{gl}(n, \mathbb{C})$. In this talk, we discuss joint work with Sam Evens in which we use the theory of

$K = GL(n-1,\mathbb{C}) \times GL(1,\mathbb{C})$-orbits on the flag variety of $\mathfrak{gl}(n,\mathbb{C})$ to study the Gelfand-Zeitlin system. In particular, we show that the irreducible components of the regular nilfiber of the moment map of the system correspond to certain Borel subalgebras constructed using the K-orbits related to the holomorphic and anti-holomorphic discrete series representations for the real group $U(n-1,1)$. We also describe our current work in using K-orbits and the Grothendieck resolution to study arbitrary Lagrangian moment map fibers. Along these lines, we prove that every Borel subalgebra contains points where the Gelfand-Zeitlin flow is Lagrangian and develop a condition that relates the length of a K-orbit through a Borel subalgebra containing elements of a given regular fiber to spectral data of elements in the fiber. (Received August 28, 2011)

1075-22-215 **Annegret Paul*** (annegret.paul@wmich.edu). *Unitary Principal Series of $SO(n+1,n)$.* Preliminary report.

The set of spherical complementary series of split classical groups is known due to Barbasch. Using an extension of his idea of "petite" K-types, we obtain an embedding of all unitary minimal principal series (not necessarily spherical) representations of $SO(n+1,n)$ into the (known) set of unitary spherical parameters for certain smaller split orthogonal groups. By an earlier result, we have an embedding of the set of genuine unitary minimal principal series of the metaplectic group into the same known set of parameters. In both cases, we conjecture that the injection is, in fact, a bijection. In particular, we expect that there is a natural bijection between the complementary series of $SO(n+1,n)$ and the genuine complementary series of $Mp(2n,\mathbb{R})$. We explore both similarities and differences between the two situations. This is joint work with A. Pantano and S. Salamanca-Riba. (Received August 30, 2011)

1075-22-226 **Dragan Milicic*** (milicic@math.utah.edu). *Geometry and Unitarity.* Preliminary report.

D-module theory allows us to approach a number of problems in representation theory of real reductive groups using methods of algebraic geometry. For a long time, all attempts to study the classification of unitary representations in this framework failed. Recently, a new idea by Vogan and his collaborators to study hermitian forms invariant for a compact form, changed the situation. Such forms can be constructed geometrically, generalizing the obvious construction on global sections of line bundles given by integration. As pointed out by Schmid and Vilonen, these forms are related to polarizations in Saito's theory of Hodge modules.

This is a joint work with Henryk Hecht. (Received August 30, 2011)

1075-22-240 **Matthew L Housley*** (housley@mathematics.byu.edu), Department of Mathematics, Brigham Young University, 342 TMCB, Provo, UT 84602. *A skein theoretic approach to Kazhdan-Lusztig representations of the symmetric group.* Preliminary report.

We will discuss construction of Kazhdan-Lusztig left cell representations of the symmetric via graphs and skein relations. (Received August 30, 2011)

1075-22-248 **Stephen DeBacker*** (smdbackr@umich.edu), 2074 East Hall, 530 Church Street, Ann Arbor, MI 48109, and **Loren Spice** (l.spice@tcu.edu), Texas Christian University, 2840 W. Bowie St F, Fort Worth, TX 76109. *A new twist in the L-packet tale.* Preliminary report.

Suppose that G is a reductive p-adic group, and T is an elliptic maximal torus in G. For each regular character ϕ of T there is a natural way to construct a supercuspidal representation $\pi(\phi,T)$ of G. It was expected that the set of representations $\{\pi(T',\phi')\}$ obtained by running over representative pairs (T',ϕ') for the rational conjugacy classes in the geometric conjugacy class of (T,ϕ) would form an L-packet. This is not the case. (Received August 31, 2011)

28 ► Measure and integration

1075-28-43 **Philip T Gressman*** (gressman@math.upenn.edu). *Fractional Poincare and logarithmic Sobolev inequalities for measure spaces.*

We discuss recent work establishing analogues of Poincare and logarithmic Sobolev inequalities for functions with a fractional degree of differentiability in measure spaces with only a minimal amount of geometric structure. Such spaces include, but are not limited to, spaces of homogeneous type with doubling measures. This work generalizes certain earlier results due to Mouhot, Russ, and Sire (2011), Lott and Villani (2009), and K. T. Sturm (2006). (Received August 15, 2011)

30 ► Functions of a complex variable

1075-30-151 **Timur Sadykov*** (sadykovtm@rsute.ru), Russian State University, of Trade and Economics, Moscow, 125993, Russia. *On analytic complexity of special functions.*

The Kolmogorov-Arnold theorem yields a representaion of a multivariate continuous function in terms of a composition of functions of at most two variables. In the analytic case, understanding the complexity of such a representation naturally leads to the notion of the analytic complexity of a bivariate (multi-valued) analytic function introduced and studied by V.K.Beloshapka (Russian J. Math. Phys. 14, no. 3, 2007, pp. 243-249.). According to Beloshapka's local definition, the order of complexity of any univariate function is equal to zero while the n-th complexity class is defined recursively to consist of functions of the form $a(b(x,y)+c(x,y))$, where a is a univariate analytic function and b and c belong to the $(n-1)$-th complexity class. With such a hierarchy of complexity classes, one can associate a number of differetial and algebraic invariants. A randomly chosen bivariate analytic function will most likely have infinite analytic complexity. However, for a number of important families of special functions their complexity is finite and can be computed or estimated. Using properties of solutions to the Hopf equation and the Gelfand-Kapranov-Zelevinsky system we obtain estimates for the analytic and polynomial complexity of such functions as well as plane webs. (Received August 28, 2011)

33 ► Special functions

1075-33-197 **Alan C Adolphson*** (adolphs@math.okstate.edu) and **Steven Sperber**. *Composition series for A-hypergeometric D-modules.* Preliminary report.

In recent work, Schulze and Walther have characterized those A-hypergeometric D-modules which are irreducible as D-modules. (The nonconfluent case was done earlier by Gelfand, Kapranov, and Zelevinsky. Recently Beukers gave a simpler proof.) We discuss some ideas related to the problem of finding composition series for A-hypergeometric D-modules. (Received August 30, 2011)

35 ► Partial differential equations

1075-35-1 **Graeme Walter Milton*** (milton@math.utah.edu), Department of Mathematics, Salt Lake City, UT 84112. *Metamaterials: high contrast composites with unusual properties.*

Metamaterials are composites with properties unlike any found in nature. For electromagnetism metamaterials open the door to interesting phenomena such as superlensing and cloaking. Metamaterials can also have an interesting elastodynamic behavior. Their effective mass density can be anisotropic, negative, or even complex. Even the eigenvectors of the effective mass density tensor can vary with frequency. One may use coordinate transformations of the elastodynamic equations to get novel unexpected behavior. A classical propagating wave can have a strange behavior in the new abstract coordinate system. However the problem becomes to find metamaterials which realize the behavior in the new coordinate system. This can be solved at a discrete level, by replacing the original elastic material with a network of masses and springs and then applying transformations to this network. The realization of the transformed network requires a new type of spring, which we call a torque spring. The forces at the end of the torque spring are equal and opposite but not aligned with the line joining the spring ends. We show how torque springs can theoretically be realized. This is joint work with M.Briane A.Cherkaev,F.Guevara Vasquez, D.Onofrei, P.Seppecher and J.R.Willis. (Received August 26, 2011)

1075-35-2 **Monica Visan*** (visan@math.ucla.edu), UCLA Mathematics Department, Box 951555, Los Angeles, CA 90095. *Dispersive PDE at critical regularity.*

We discuss recent developments in the global (in time) theory and asymptotic behavior of dispersive equations at critical regularity. (Received August 22, 2011)

1075-35-20 **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 Schrodinger 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 such 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 July 25, 2011)

1075-35-21 **M Burak Erdoğan** and **William R Green*** (wrgreen2@eiu.edu), 600 Lincoln Ave., Charleston, IL 61920. *Dispersive estimates for Schrödinger operators in dimension two with obstructions at zero energy.*

Consider the Schrödinger operator $H = -\Delta + V$ on $\mathbb{R}^2$ and $P_{ac}(H)$ the projection onto the absolutely continuous spectrum of H. When $V = 0$, the evolution of the solution operator satisfies $\|e^{itH}\|_{1\to\infty} \lesssim |t|^{-1}$. We prove dispersive, $L^1(\mathbb{R}^2) \to L^\infty(\mathbb{R}^2)$, estimates for the evolution $e^{itH}P_{ac}(H)$ when there are obstructions, resonances and/or an eigenvalue of H at zero energy. The obstructions are related to distributional solutions to the equation $H\psi = 0$. The obstructions are characterized by the values of p for which $\psi \in L^p(\mathbb{R}^2)$.

In particular, we show that the existence of an 's-wave' resonance of H at zero energy does not destroy the t^{-1} decay rate. We also show that the existence of a 'p-wave' resonance or eigenvalue at zero energy destroys the decay rate, but does lead to a bounded evolution. (Received August 23, 2011)

1075-35-31 **Niklas Wellander*** (niklas.wellander@eit.lth.se), P.O. Box 1165, SE-58111 Linköping, Sweden. *Homogenization of a Nonlocal Electrostatic Equation.* Preliminary report.

We find the effective conductivity of a composite when the current density is given as a spatial convolution of the electric field with a conductivity kernel. It turns out that the homogenized equation is supplied with a nonlocal constitutive relation if the non-local dependence does not scale. The domain, Ω, is assumed to be a bounded subset of $\mathbb{R}^n$, $n \in \mathbb{N}$ with a Lipshitz boundary $\partial\Omega$. The current density is given by a spatial convolution of the electric field with a nonlocal kernel which gives the current density contribution at a point due to the electric field in a neighborhood of x. The weak electrostatic equation reads: find $\phi^\varepsilon \in H_0^1(\Omega)$ such that

$$\int_\Omega \int_\Omega K^\varepsilon(x-\xi)\nabla\phi(\xi)\,\mathrm{d}\xi \cdot \nabla\psi(x)\,\mathrm{d}x = \int_\Omega f^\varepsilon(x)\psi(x)\,\mathrm{d}x$$

$\forall\psi \in H_0^1(\Omega)$. The fine scale structure in the composite is modeled by the parameter $\varepsilon > 0$. The source f^ε is bounded in $L^2(\Omega)$ and converges strongly to f in $H^{-1}(\Omega)$ when $\varepsilon \to 0$. (Received August 26, 2011)

1075-35-42 **Kenji Nakanishi** and **Tuoc Van Phan*** (phan@math.utk.edu), 227 Ayres Hall, 1403 Circle Drive, Knoxville, TN 37996-1320, and **Tai-Peng Tsai**. *Small solutions of nonlinear Schrödinger equations near first excited states.*

Consider a nonlinear Schrödinger equation in $\mathbb{R}^3$ whose linear part has three or more eigenvalues satisfying some resonance conditions. Solutions which are initially small in $H^1 \cap L^1(\mathbb{R}^3)$ and inside a neighborhood of the first excited state family are shown to converge to either a first excited state or a ground state at time infinity. An essential part of our analysis is on the linear and nonlinear estimates near nonlinear excited states, around which the linearized operators have eigenvalues with nonzero real parts and their corresponding eigenfunctions are not uniformly localized in space.

This is the joint work with Kenji Nakanishi and Tai-Peng Tsai. (Received August 15, 2011)

1075-35-46 **Houman Owhadi*** (owhadi@caltech.edu), Caltech MC 9-94, 1200 E California blvd, Pasadena, CA 91125. *From homogenization with non separated scales to discrete geometric structures in inverse homogenization.*

In the first part of this talk we show how homogenization theory and (localized) cell problems can be generalized to divergence form operators with arbitrary rough coefficients. This generalization does not rely on concepts of ergodicity, epsilon sequences or scale-separation but on the property that the solution space of these operators is compactly embedded in H^1 if source terms are in the unit ball of L^2 instead of the unit ball of H^{-1}. In the second part of this talk we show that homogenization can be written as the composition of a nonlinear bijection with a non-injective linear operator (more precisely, although homogenization is a non-linear and non-injective operator when applied directly to conductivity coefficients, it becomes a linear interpolation operator over triangulations of the physical domain when re-expressed using convex functions) and show how this observation can be applied to inverse problems (such as EIT). Various parts of this talk are joint work with Leonid Berlyand, Mathieu Desbrun, Roger Donaldson and Lei. Zhang. (Received August 15, 2011)

1075-35-52 **Chongsheng Cao** and **Jiahong Wu*** (jiahong@math.okstate.edu), Department of Mathematics, 401 Mathematical Sciences, Oklahoma State University, Stillwater, OK 74078. *Global regularity for the 2D anisotropic Boussinesq equations with vertical dissipation.*

This talk presents a very recent result asserting the global (in time) regularity of classical solutions to the 2D anisotropic Boussinesq equations with only vertical dissipation. The Boussinseq 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. To solve this problem, we bound the derivatives in terms of the L^∞-norm of the vertical velocity v and prove that $\|v\|_{L^r}$ with $2 \le r < \infty$ at any time does not grow faster than $\sqrt{r \log r}$ as r increases. A delicate interpolation inequality connecting $\|v\|_{L^\infty}$ and $\|v\|_{L^r}$ then yields the desired global regularity. (Received August 17, 2011)

1075-35-57 **Leonid Kunyansky*** (leonk@math.arizona.edu), Department of Mathematics, University of Arizona, 617 N Santa Rita Ave., Tucson, AZ 85721. *Conductivity reconstruction using hybrid modalities with synthetic focusing.*

Reconstruction of conductivity by means of purely electrical measurements (as in the electric impedance tomography, or EIT) is known to be extremely unstable. In order to overcome this instability, one can try to modulate the electric currents by ultrasound waves. This idea is used, in particular, in Acousto-Electric tomography (AEIT) and in Magneto-Acousto-Electric tomography (MAET). Both modalities rely on the so-called synthetic focusing which allows one to obtain the measurements that would correspond to an acoustic beam focused into a point, from realistic measurments corresponding to propating spherical fronts. In the talk I will present recent results on the use of synthetic focusing in AEIT and MAET. (Received August 18, 2011)

1075-35-68 **Nghiem V. Nguyen*** (nghiem.nguyen@usu.edu), Department of Mathematics and Statistics, Utah State University, 3900 Old Main Hill, Logan, UT 84322-3900, and **Zhi-Qiang Wang**. *Orbital stability of solitary waves of a 3-coupled nonlinear Schrödinger system.*

In this talk, consideration is given to the 3−coupled nonlinear Schrödinger system

$$i\frac{\partial}{\partial t}u_j + \frac{\partial^2}{\partial xx}u_j + \sum_{i=1}^{3} b_{ij}|u_i|^2 u_j = 0,$$

where u_j are complex-valued functions of $(x,t) \in \mathbb{R}^2$, $j = 1,2,3$, and b_{ij} are positive constants satisfying $b_{ij} = b_{ji}$. It will be shown first that if the symmetric matrix $B = (b_{ij})$ satisfies certain conditions, then ground-state solutions of the 3−coupled nonlinear Schrödinger system exist, and moreover, they are orbitally stable. The theory is then extended to include solitary waves as well. In particular, it will be shown that when a solitary wave is perturbed, the perturbed solution must stay close to a solitary-wave profile in which the translation and phase parameters are prescribed functions of time. Properties of these functions are then studied. This is a continuous work of our previous paper where the 2−coupled nonlinear Schrödinger system was considered. (Received August 22, 2011)

1075-35-69 **Vishal Vasan*** (vvasan@uw.edu), Department of Applied Mathematics, University of Washington, Guggenheim Hall 414, Box 352420, Seattle, WA 98195, and **Bernard Deconinck**, Department of Applied Mathematics, University of Washington, Guggenheim Hall 414, Box 352420, Seattle, WA 98195. *Well-posedness of boundary-value problems for the linear Benjamin-Bona-Mahony equation.*

A new method due to Fokas for explicitly solving boundary-value problems for linear partial differential equations is extended to equations wit mixed partial derivatives. The Benjamin-Bona-Mahony equation is used as an example: we consider the Robin problem for this equation posed both on the half line and on the finite interval. For specific cases of the Robin boundary conditions the boundary-value problem is found to be ill posed. (Received August 22, 2011)

1075-35-71 **Maria Emelianenko*** (memelian@gmu.edu), Department of Mathematical Sciences, MS 3F2, George Mason University, 4400 University Dr, Fairfax, VA 22030. *Advances in Multiscale Modeling of Grain Growth in Polycrystals.*

This talk will focus on the simulation and analysis of the effects grain growth has on the properties of polycrystalline materials. Several kinetic models have been developed in recent years that can predict coarsening rates and accurately describe evolution of important grain boundary distributions. Here we will focus on the progress made in combining these novel mesoscopic level descriptions with macroscopic microstructure analysis tools such as OOF2. In particular, we will discuss the strategy for quantifying the rates of degradation experienced by the microstructure during coarsening and assess the impact texture and other initial grain boundary distributions

have on the local stress/strain development and other materials properties. Some discussion of the novel simulation and numerical modeling techniques used in this analysis will also be provided. (Received August 22, 2011)

1075-35-76 **Fernando Guevara Vasquez*** (fguevara@math.utah.edu), Mathematics Department, University of Utah, 155 S 1400 E Room 233, Salt Lake City, UT 84112, and **Graeme W. Milton** and **Daniel Onofrei**. *Active exterior cloaking for the Helmholtz equation.*

We present a way of using active sources to hide objects from a known incident field. The active sources cancel out the incident field in a region while having a small far field. Since very little waves reach objects in the cloaked region, the scattered field is greatly diminished, making the object practically invisible. We recall how to construct such a cloak using a single and double layer potential on a surface (Green's formulas) and then show how the same effect can be achieved using a few multipolar sources that do not completely surround the cloaked region. We report on progress towards generalizing this approach to the Maxwell equations. (Received August 22, 2011)

1075-35-78 **Nicolae Tarfulea*** (tarfulea@purduecal.edu), Purdue University Calumet, Department of Mathematics, 2200 169th Street, Hammond, IN 46323. *On Differential Equations with Constraints.* Preliminary report.

In this talk we address the initial and initial-boundary value problems for differential equations with constraints. Under certain compatibility conditions, the constraints are preserved by the evolution for the initial value problem. However, for an initial-boundary value problem, this will not be the case. It has become increasingly clear that in order for constraints to be preserved during evolution, the boundary conditions have to be chosen in an appropriate way. Finding such boundary conditions is not an easy task, but it is essential for computing accurate numerical solutions. Here we consider boundary conditions for a first order hyperbolic system which are well-posed, and establish a sufficient condition for them to be constraint-preserving. Our condition is based on a second, extended system which we construct, and which we show is equivalent to the original one when the boundary conditions are constraint-preserving. We believe that for the extended system it will be easier to control constraint violations during numerical simulations because of the way that the constraints directly enter the evolution, and so it may present a preferable alternative to the original system for numerical approximation. This is a joint work with Douglas N. Arnold, University of Minnesota. (Received August 22, 2011)

1075-35-86 **Vedran Sohinger*** (vedrangustav@gmail.com), University of Pennsylvania Mathematics Dept., D. Rittenhouse Lab, 209 S 33rd St., Philadelphia, PA 19104, and **Gigliola Staffilani** (gigliola@math.mit.edu), MIT Math Dept. Building 2, 77 Massachusetts Avenue, Cambridge, MA 02139. *On the uniqueness of solutions to the 3D periodic Gross-Pitaevskii hierarchy.*

In this talk, we present a uniqueness result for solutions to the Gross-Pitaevskii hierarchy on the three-dimensional torus, under the assumption of an a priori spacetime bound. We show that this a priori bound is satisfied for factorized solutions coming from a solution of the nonlinear Schrodinger equation. This is the periodic analogue of the uniqueness result on $\mathbb{R}^3$ previously proved by Klainerman and Machedon. This is joint work with Gigliola Staffilani. (Received August 23, 2011)

1075-35-92 **Mahadevan Ganesh*** (mganesh@mines.edu), Department of Applied Mathematics and Statist, Golden, CO 80401. *A reduced basis method for multiple electromagnetic scattering.*

We consider a parameterized multiple particle wave propagation model in three dimensions. The parameters in the model describe the location, orientation, size, shape, and number of scattering particles as well as properties of the input source field such as the frequency, polarization, and incident direction. The need for fast and efficient (online) simulation of the interacting scattered fields under parametric variation of the multiple particle surface scattering configuration is fundamental to several applications for design, detection, or uncertainty quantification.

For such dynamic parameterized multiple scattering models, the standard discretization procedures are prohibitively expensive due to the computational cost associated with solving the full model for each online parameter choice. In this work, we propose an iterative offline/online reduced basis approach for a boundary element method to simulate a parameterized system of surface integral equations reformulation of the multiple particle wave propagation model.

(This is a joint work with J. Hesthaven and B. Stamm.) (Received August 23, 2011)

1075-35-93 **Markus Keel**, Department of Mathematics, The University of Minnesota, Minneapolis, MN 55455, and **Shuanglin Shao*** (slshao@math.ku.edu), Department of Mathematics, 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 August 24, 2011)

1075-35-96 **Netra P Khanal*** (nkhanal@ut.edu). *A dual-Petrov-Galerkin method for extended fifth-order Korteweg-de Vries type equations.*

The dual-Petrov-Galerkin method is applied to several integrable and non-integrable fifth-order KdV type equations. The method is implemented to compute the solitary wave solutions of these equations and the numerical results imply that this scheme is capable of capturing, with very high accuracy, the details of these solutions with modest computational costs. (Received August 23, 2011)

1075-35-114 **Min Chen*** (chen45@purdue.edu), Min Chen, Dept. of Mathematics, Purdue University, West Lafayette, IN 47906. *Comparison between Boussinesq system and KP equation.*

In this talk, we will derive KP equation from Boussinesq system, and compare various properties of these two equations both theoretically and numerically. (Received August 25, 2011)

1075-35-116 **Linh V Nguyen*** (lnguyen@uidaho.edu). *Some mathematical problems of thermoacoustic tomography.*

Thermoacoustic tomography (TAT) is a hybrid medical imaging modality. A brief pulse of electromagnetic (EM) radiation is scanned through the biological tissue to slightly heat it up. The elastic expansion of the tissue leads to an ultrasound (pressure) wave propagation. The wave is measured by transducers on an observation surface. From this data, one reconstructs the initial pressure distribution, and thus the EM absorption inside the body.

In this talk, we address the following two issues of TAT:

1. Instability: we prove that the reconstruction is not Hölder stable if a natural visibility condition is violated. This complements the results by V. Palamodov (for constant speed) and P. Stefanov and G. Uhlmann (for variable speed), which show that under the visibility condition, the reconstruction is Lipschitz stable.

2. Speed determination in TAT: most of the work done in TAT assumes that the ultrasound speed is known. However, it is usually not known in applications. It is natural to ask whether the TAT data could determine both the ultrasound speed and the initial pressure. We will present some partial answers to this question (joint work with M. Agranovsky and P. Kuchment). (Received August 25, 2011)

1075-35-123 **Benoit Pausader*** (benoit.pausader@gmail.com). *The energy-critical NLS in the Torus and related spaces.*

We discuss recent developments on the defocusing energy-critical Nonlinear Schrodinger equation with periodic initial data in dimensions three and related topics. (Received August 25, 2011)

1075-35-125 **Rushun Tian*** (rushun.tian@aggiemail.usu.edu) and **Zhi-Qiang Wang**. *Multiple Solitary Wave Solutions of Nonlinear Schrödinger Systems.*

We study multiplicity of solitary wave solutions of nonlinear Schrödinger system of equations,

$$\begin{cases} -\Delta U_j + U_j = \mu U_j^3 + \beta U_j \sum_{k\neq j} U_k^2, & \text{in } \Omega, \\ U_j > 0 \text{ in } \Omega, U_j = 0 \text{ on } \partial\Omega, & j = 1, \cdots, N, \end{cases}$$

where Ω is a smooth and bounded (or unbounded if Ω is radially symmetric) domain in $\mathbb{R}^n$, $n \leq 3$.

Using index theory, solution orbits with different symmetry are found on different energy levels of the corresponding functional. The parameter β plays an important role in this process, and its value is used to estimate the number of different solution orbits. (Received August 25, 2011)

1075-35-145 **Hongqiu CHEN*** (hchen1@memphis.edu), University of Memphis, Department of Mathematical Sciences, Memphis, TN 38152, and **Jerry L BONA**. *Well-posedness for systems of coupled BBM-equations.* Preliminary report.

In this lecture, we introduce a system

$$u_t + u_x - u_{xxt} + P(u, v)_x = 0,$$

$$v_t + v_x - v_{xxt} + Q(u,v)_x = 0$$

of coupled BBM-type equations, where $u = u(x,t), v = v(x,t)$ are functions defined for $x \in (-\infty, \infty)$ and $t \in [0,\infty)$. $P(u,v) = Au^2 + Buv + Cv^2$ and $Q(u,v) = Du^2 + Euv + Fv^2$ in which $A, B, \cdots, F$ are real number constants. It is an alternative model to the one recently introduced by Bona , Cohen and Wang:

$$u_t + u_x + u_{xxx} + P(u,v)_x = 0,$$
$$v_t + v_x + v_{xxx} + Q(u,v)_x = 0$$

We show that it is well-posed locally in time in $H^s \times H^s$ for any $s \geq 0$. Furthermore, under certain conditions on P and Q, the system is well-posed globally in time. (Received August 27, 2011)

1075-35-152 **Mihai Mihailescu*** (mmihailes@yahoo.com), 13, A. I. Cuza, 200585 Craiova, Romania, 200585 Craiova, Dolj, Romania. *A maximum principle connected with eigenvalue problems involving variable exponents.*

The main interest of this talk is given by the following maximum principle: *Assume $\Omega \subset \mathbb{R}$ ($N \geq 2$) is an open, bounded and smooth set with smooth boundary. Let $p : \overline{\Omega} \to (1,\infty)$ be a continuous function of class C^1 in Ω. Let $\overrightarrow{a} : \Omega \to \mathbb{R}^N$ be a vectorial function of class C^1 for which there exists $a_0 > 0$ a constant such that $\operatorname{div}\overrightarrow{a}(x) \geq a_0 > 0$, for all $x \in \overline{\Omega}$. Furthermore, assume that $\overrightarrow{a}(x) \cdot \nabla p(x) = 0$, for all $x \in \Omega$. Then for each open set $U \subset \Omega$ the maximum and the minimum of p on $\overline{U}$ are achieved on ∂U.*

We highlight some connections between the above maximum principle and the fact that under the same assumptions on functions p and $\overrightarrow{a}$ we have $\inf_{u \in C_0^\infty(\Omega)\setminus\{0\}} \frac{\int_\Omega |\nabla u|^{p(x)}\, dx}{\int_\Omega |u|^{p(x)}\, dx} > 0$. (Received August 28, 2011)

1075-35-163 **Pengfei Guan** and **Junfang Li*** (jfli@uab.edu). *A fully non-linear flow equation on the sphere and Alexandrov-Fenchel inequalities.* Preliminary report.

In this talk, we will introduce a fully nonlinear parabolic partial differential equation defined on the sphere. We will discuss the long time existence and exponential convergence of the flow. As an application we prove the Alexandrov-Fenchel inequalities including the classical isoperimetric inequality for star-shaped domains in Euclidean space. (Received August 29, 2011)

1075-35-179 **Rowan Killip** (killip@math.ucla.edu), UCLA Mathematics Department, Box 951555, Los Angeles, CA 90095-1555, **Betsy Stovall*** (betsy@math.ucla.edu), UCLA Mathematics Department, Box 951555, Los Angeles, CA 90095-1555, and **Monica Visan** (visan@math.ucla.edu), UCLA Mathematics Department, Box 951555, Los Angeles, CA 90095-1555. *On finite time blowup solutions to certain nonlinear Klein–Gordon equations.*

In this talk, we will consider the focusing nonlinear Klein–Gordon equation

$$u_{tt} - \Delta u + m^2 u = |u|^p u,$$

for $0 \leq m \leq 1$, $\frac{4}{d} < p < \frac{4}{d-2}$, $d \geq 2$, with initial data $u(0) \in H^1(\mathbb{R}^d)$, $u_t(0) \in L^2(\mathbb{R}^d)$. For a solution u which blows up in finite time, we study the behavior of various norms of $u(t)$ and $u_t(t)$ as t approaches the blowup time. This is joint work with Rowan Killip and Monica Vişan. (Received August 29, 2011)

1075-35-182 **Paul Smith***, University of California, Berkeley, 970 Evans Hall #3840, Berkeley, CA 94720. *Conditional global regularity of Schrödinger maps: sub-threshold dispersed energy.*

In 2008, Bejenaru, Ionescu, Kenig, and Tataru jointly proved global-wellposedness in dimensions $d \geq 2$ for the Schrödinger maps initial-value problem

$$\begin{cases} \partial_t \phi &= \phi \times \Delta\phi \text{ on } \mathbb{R}^d \times \mathbb{R} \\ \phi(0) &= \phi_0, \end{cases}$$

$\phi : \mathbb{R}^d \times \mathbb{R} \to \mathbb{S}^2 \hookrightarrow \mathbb{R}^3$, under the assumption that ϕ_0 is sufficiently small in $\dot{H}^{d/2}$. Working in the $d = 2$ energy-critical setting, we prove a conditional global regularity result valid for a class of ϕ_0 with energy up to the ground-state 4π threshold. Developing the caloric gauge in the sub-threshold setting sets the groundwork for this extended result, though the key improvements come from a tailored local smoothing estimate for a magnetic Schrödinger equation and from a closely-related bilinear Strichartz estimate. (Received August 29, 2011)

1075-35-188 **Emily J Evans*** (montu.gm@gmail.com), TMCB 275, Brigham Young University, Provo, UT 84602. *Finite Element Techniques for Prefractal Problems.*

In this talk we will consider numerically solving problems on domains with prefractal Koch curve boundaries. Discretization of these domains is interesting as the mesh must be adapted to both the fractal iterations as well as any refinement that must occur due to singular points. In our talk we will describe construction of these meshes as well as refinement techniques to account for singularities in these domains. (Received August 29, 2011)

1075-35-204 **Shari Moskow***, moskow. *Scattering and Resonances of Thin High Contrast Dielectric Structures.*

joint work with D. Ambrose; J. Gopalakrishnan, F. Santosa and J. Zhang (Received August 30, 2011)

1075-35-205 **Shari Moskow***, moskow. *Inverse Born Series for the Calderon Problem.*

joint work with S. Arridge and J. Schotland (Received August 30, 2011)

1075-35-211 **John Carter*** (carterj1@seattleu.edu), Seattle University, 901 12th Ave, Seattle, WA 98122, and **Rodrigo Cienfuegos** (racienfu@ing.puc.cl), Departamento Ingenieria Hidraulica y Ambi, Pontificia Universidad Catolica de Chile, Santiago, Chile. *Kinematics & Stability of Solutions to the Serre Equations.*

The Serre equations are a pair of strongly nonlinear, weakly dispersive, Boussinesq-type partial differential equations. They model the evolution of the surface elevation and the depth-averaged horizontal velocity of an inviscid, irrotational, incompressible, shallow fluid. They admit a three-parameter family of cnoidal wave solutions with improved kinematics when compared to KdV theory. We examine their linear stability and establish that waves with sufficiently small amplitude/steepness are stable while waves with sufficiently large amplitude/steepness are unstable. (Received August 30, 2011)

1075-35-225 **John Albert*** (jalbert@ou.edu), 601 Elm Ave., Rm. 423, Norman, OK 73019, and **Santosh Bhattarai** (sbhattarai@math.ou.edu), 601 Elm Ave, Rm 423, Norman, OK 73019. *Stability of solitary waves for a KdV-NLS system.*

A universal model for the interaction of long nonlinear waves and packets of short waves with long linear carrier waves is given by a system in which an equation of Korteweg-de Vries type is coupled to an equation of nonlinear Schrödinger type. The system has solutions of steady form in which one component is like a solitary-wave solution of the KdV equation and the other component is like a ground-state solution of the NLS equation. The existence of such solutions can be shown by variational methods in which the constraints are positive definite; however proving the stability of the solutions is more difficult because standard techniques require analyzing a variational problem in which the constraints are not positive definite. We give a sufficient condition for certain of the steady solutions to be stable. The result is related to recent work of Angulo and of Dias, Figueira, and Oliveira. (Received August 30, 2011)

1075-35-229 **Andrej Cherkaev*** (cherk@math.utah.edu), 155 E 1400 S, JWB, Salt Lake City, UT 84112. *Optimal Three-Material Wheel Assemblage of Conducting and Elastic Composites.*

We describe a new type of three material microstructures which we call *wheel assemblage*, that correspond to extremal conductivity and extremal bulk modulus for a composite made of two materials and an ideal material. The exact lower bound for effective conductivity and matching laminates were found in (Cherkaev, 2009) and for anisotropic composites, in (Cherkaev, Zhang, 2011). Here, we show different optimal structures that generalize of the classical Hashin-Shtrikman coated spheres (circles). They consists of circular inclusions which contain a solid central circle (hub) and radial spikes in a surrounding annulus, and (for larger volume fractions of the best material) an annulus filled with it. The same wheel assemblages are optimal for the couple of dual problems of minimal conductivity (resistivity) of a composite made from two materials and an ideal conductor (insulator), in the problem of maximal effective bulk modulus of elastic composites made from two linearly elastic material and void, and the dual one. (Received August 30, 2011)

1075-35-232 **Jingyi Zhu*** (zhu@math.utah.edu), 155 South 1400 East JWB 233, Salt Lake City, UT 84112. *Numerical Implementation of Volatility Boundary Conditions in Stochastic Volatility Models.* Preliminary report.

Option pricing based on stochastic volatility models can reproduce volatility skew/smile observed on the market. The use of these models typically relies on either closed-form solutions or Monte Carlo simulations, each with obvious limitations. Finite difference methods to solve the resulting time-dependent PDE in two space dimensions provide a powerful alternative, with advantages such as natural accommodation of correlation and variable coefficients. One less obvious but potentially critical issue is the implementation of boundary condition imposed at the zero volatility boundary. In this work, we consider the full PDE problem and associate different boundary conditions with the corresponding stochastic process in various regimes, and use high-order finite difference methods to analyze the boundary impact. Using the settings of Heston and SABR models, we present numerical results, in terms of the market observable "volatility smile" curve, to demonstrate the ramifications of the boundary treatments. The importance of this issue is made obvious in exotic options such as the one-touch options in currency trading. Comparisons with other approaches such as Monte Carlo simulations are also made to show the advantage of the finite difference methods. (Joint with Peter Laurence) (Received August 30, 2011)

1075-35-238 **Stephen Pankavich*** (pankavic@usna.edu), Department of Mathematics, United States Naval Academy, 572C Holloway Rd, Annapolis, MD 21402. *Regularity for a model of collisionless plasma in low dimension.* Preliminary report.

The fundamental kinetic description of a collisionless plasma is given by the Vlasov-Maxwell (VM) equations. When relativistic velocity effects are not present in the model, the existence and regularity of classical solutions to this system of nonlinear hyperbolic PDE is still unknown, even for the lowest dimensional representation. We consider a "one-and-one-half"-dimensional analogue of (VM) and present recent analytical results concerning the regularity and behavior of solutions. (Received August 30, 2011)

1075-35-244 **Marian Bocea*** (mbocea@luc.edu), Department of Mathematics and Statistics, Loyola University Chicago, 1032 W. Sheridan Road, Chicago, IL 60660. *A Caffarelli-Kohn-Nirenberg inequality in Orlicz-Sobolev spaces and applications.*

A generalization of the classical Caffarelli-Kohn-Nirenberg inequality is obtained in the setting of Orlicz-Sobolev spaces. As applications, we prove a compact embedding result, and establish existence of solutions for a degenerate/singular elliptic PDE. Joint work with Mihai Mihailescu (University of Craiova, Romania). (Received August 30, 2011)

37 ► Dynamical systems and ergodic theory

1075-37-39 **Zhifu Xie***, Department of Mathematics & Computer Science, P.O. Box 9068, Virginia State University, Chester, VA 23806. *Golden Ratio and Super Central Configurations of N-body Problem.*

A new phenomenon on central configurations was discovered in the collinear three-body problem and in the collinear four-body problem. There exists a configuration that is a central configuration for at least two different arrangements of a given mass vector. Such central configuration is called the super central configuration in the n-body problem and it may lead some surprising dynamical behaviors. Super central configurations do not exist in the planar four-body problem. The existence and classifications of super central configuration in the collinear cases are also very important for counting the number of central configurations under different equivalent classes. Remarkably the existence of super central configurations in general homogeneous potential has a relation to the Mathematical Beatuy- Golden Ratio. (Received August 13, 2011)

1075-37-117 **Antonio Garcia*** (agar@xanum.uam.mx), Av. San Rafael Atlixco No. 186 Col. Vicentina, 09340 Iztapalapa, DF, Mexico, and **Martha Alvarez**. *Symbolic dynamics in a restricted planar 4-body problem.* Preliminary report.

In this talk we present a (3+1)-body problem. The aim is to construct symbolic dynamics avoiding the use of the transversality of the stable and unstable manifolds of a hyperbolic structure. Instead of it, we construct numerically a Smale horseshoe using correctly aligned windows. (Received August 25, 2011)

1075-37-185 **Tiancheng Ouyang*** (ouyang@math.byu.edu), Department of Mathematics, Brigham Young University, Provo, UT 84602, and **Duokui Yan** (duokuiyan@hotmail.com), School of Mathematics and System Sciences, Beihang University, Beijing, 100191, Peoples Rep of China. *Simultaneous Binary Collisions for the Collinear Four-Body Problem.* Preliminary report.

In this talk, we study the structure of solutions of simultaneous binary collision (SBC) in the collinear four-body problem with equal masses. We explore new developments in the regularization of SBC. A canonical transformation of Levi-Civita type is introduced to regularize the singularity of SBC. Given any initial condition leading to SBC, the collision solution is unique up to SBC. However, there are infinitely many ejection solutions corresponding to this collision solution under the transformed variables. (Received August 29, 2011)

1075-37-208 **Duokui Yan*** (duokuiyan@gmail.com), Beihang University, Haidian District Xueyuan Rd #37, Beijing, Beijing 100191, Peoples Rep of China. *A Simple Existence Proof of the Schubart Periodic Orbit with Arbitrary Masses.*

This paper gives a surprisingly simple existence proof of the Schubart periodic orbit with arbitrary masses, a periodic orbit with singularities in the collinear three-body problem. A "turning point" technique is applied to study the shape of the orbit and the existence follows by a continuity argument on differential equations generated by the regularized Hamiltonian. (Received August 30, 2011)

1075-37-227 **Ernesto A Lacomba*** (lace@xanum.uam.mx), Mathematics Department, University Autonoma Metropolitana, Iztapalapa, Av San Rafael Atlixco 186, 09340 Mexico, DF, Mexico, and **Martin Celli** and **Ernesto Pérez-Chavela**. *Relative equilibria with one or two concentric polygons in the N-vortex problem.*

Helmholtz's equations provide the motion of a system of N vortices which describes a planar incompressible fluid with zero viscosity. A relative equilibrium is a particular solution of these equations for which the distances between the vortices are invariant during the motion. In this article, we first show that a relative equilibrium formed of a regular polygon and a possible vortex at the center, with more than three vertices on the polygon (two if there is a vortex at the center), requires equal vorticities on the polygon. We also provide an 8-vortex configuration, formed of two concentric squares making an angle of 45 degrees, with uniform vorticity on each square, which is in relative equilibrium for any value of the vorticities. Then we study in general the existence of relative equilibria consisting of two concentric polygons. (Received August 30, 2011)

1075-37-251 **Tiancheng Ouyang*** (ouyang@math.byu.edu), Department of Mathematics, Brigham Young University, Provo, UT 84602, and **Duokui Yan** (duokuiyan@hotmail.com), School of Mathematics and System Sciences, Beihang University, Beijing, 100191, Peoples Rep of China. *Simultaneous Binary Collisions for the Collinear Four-Body Problem.* Preliminary report.

In this talk, we study the structure of solutions of simultaneous binary collision (SBC) in the collinear four-body problem with equal masses. We explore new developments in the regularization of SBC. A canonical transformation of Levi-Civita type is introduced to regularize the singularity of SBC. Given any initial condition leading to SBC, the collision solution is unique up to SBC. However, there are infinitely many ejection solutions corresponding to this collision solution under the transformed variables. (Received September 02, 2011)

42 ► Fourier analysis

1075-42-50 **Joshua Zahl*** (jzahl@zahl.ca). *A variable coefficient Wolff circular maximal function.*

We consider a variable coefficient generalization of the Wolff circular maximal function. In 1997, Thomas Wolff proved sharp L^3 bounds for the Wolff circular maximal function, which takes maximal averages over circles with a prescribed radius and arbitrary center. We prove the same bounds for a variable coefficient version in which circles are replaced by curves satisfying the *cinematic curvature condition*, which was first introduced by Sogge. Our proof makes use of the discrete polynomial ham sandwich theorem of Guth and Katz, and our techniques also provide a shorter proof of Wolff's original result. (Received August 16, 2011)

1075-42-131 **Zaher Hani*** (hani@cims.nyu.edu), New York, NY 10012. *Oscillatory integrals related to eigenfunction and Strichartz estimates on compact manifolds.*

We consider some oscillatory integral operators that are motivated by parametrix expressions for eigenfunctions or solutions to linear dispersive PDE on compact manifolds without boundaries. We also discuss some applications to well-posedness problems in nonlinear PDE. (Received August 26, 2011)

1075-42-135 **Richard L Oberlin*** (richard.oberlin@gmail.com). *Variations on the Carleson-Hunt theorem.*

We discuss recent results related to the pointwise convergence of Fourier integrals. (Received August 26, 2011)

46 ► Functional analysis

1075-46-15 **Saroj Aryal*** (saryal@uwyo.edu), Mathematics Department, 1000 E. University Avenue, Laramie, WY 82072, and **Farhad Jafari**. *Exploring sub-moment sequences and solutions to sub-moment problems.* Preliminary report.

In many problems associated with realization of a signal or an image, data may be corrupted or missing. Reconstruction of a function from moment sequences with missing elements is an interesting problem leading to several advances in image and/or signal reconstruction.

The well-known theorems of Hamburger, Carathéodory and Nevanlinna establish conditions on finite sequences of real numbers to be the moments corresponding to functions in various function spaces. It is easy to show that a subsequences of a moment may not be a moment sequence. Conditions are obtained to show how rigid the space of sub-moment sequences of a moment sequences are. Some characteristics of the spaces of functions reconstructed from sub-moment problems are explored. (Received July 02, 2011)

49 ► Calculus of variations and optimal control; optimization

1075-49-61 **Andrew Lorent*** (lorentaw@uc.edu), University of Cincinnati, Clifton Avenue, Cincinnati, OH 45219. *On the problem of characterizing the minimizers of the Aviles Giga functional.*

Given a connected Lipschitz domain Ω we let $\Lambda(\Omega)$ be the subset of functions in $W^{2,2}(\Omega)$ with $u = 0$ on $\partial\Omega$ and whose gradient (in the sense of trace) satisfies $\nabla u(x) \cdot \eta_x = 1$ where η_x is the inward pointing unit normal to $\partial\Omega$ at x. The functional $I_\epsilon(u) = \frac{1}{2}\int_\Omega \epsilon^{-1}\left|1 - |\nabla u|^2\right|^2 + \epsilon\left|\nabla^2 u\right|^2 dz$ minimised over $\Lambda(\Omega)$ serves as a model in connection with problems in liquid crystals and thin film blisters, it is also the most natural higher order generalization of the Modica Mortola functional. This functional is known as the Aviles Giga functional, we discuss the two main open problems concerning this functional focusing principally on the problem of characterizing the minimizers. We will survey the results of Jabin, Otto, Perthame, Aviles, Giga and a recent quantitative generalization. (Received August 19, 2011)

1075-49-157 **Farhod Abdullayev*** (farkhad.abdullaev@ndsu.edu), Department of Mathematics, North Dakota State University, NDSU Dept. #2750, P.O. Box 6050, Fargo, ND 58108-6050. *A variational characterization of the effective yield set for ionic polycrystals.*

The effective yield set for ionic polycrystals is characterized by means of a family of variational principles associated to supremal functionals acting on matrix-valued divergence-free fields.Joint work with Marian Bocea (Loyola University Chicago) and Mihai Mihailescu (University of Craiova, Romania). (Received August 28, 2011)

1075-49-170 **Rustum Choksi**, **Irene Fonseca** and **Barbara Zwicknagl*** (bzwick@andrew.cmu.edu). *Comparison of Variational Models for Denoising of Images.* Preliminary report.

Several variational models have been proven useful for the denoising of natural images. The most prominent ones include the Rudin Osher Fatemi model and higher-order models. They usually consist of a fidelity term and a regularization term where the two terms are weighted by a regularization parameter to be chosen a priori. In this talk, we compare recovery and stability properties of various variational models. This includes the impact of noise in the data, consistency properties and the numerical computability of approximations. (Received August 29, 2011)

1075-49-210 **Marcelo Bertalmío** and **Stacey Levine*** (sel@mathcs.duq.edu), Department of Mathematics, 440 College Hall, Pittsburgh, PA 15282. *A variational approach for exposure bracketed images.*

We propose a variational approach for fusing a set of images taken with different exposure times so that optimal information is obtained from each one. The solution is a single image whose details and edges are extracted from a short exposure time image (typically low contrast) and color information is extracted from a long exposure time image (often suffering from motion blur). The approach is well posed and generally preserves level lines from the low contrast image. The method is able to handle camera and subject motion as well as noise, and results compare favorably with the state of the art. (Received August 30, 2011)

51 ► Geometry

1075-51-38 **Hulya Kadioglu*** (kayahuly@isu.edu) and **Tracy L. Payne** (payntrac@isu.edu). *Classification of 7 and 8 Dimensional Soliton Nilpotent Lie Algebras.*

We present a computational method for classifying nilsoliton Lie algebras in a large subclass of the set of all nilpotent Lie algebras. We use it to classify the nilpotent Lie algebras which admit a nilsoliton inner product in this subclass in dimensions 7 and 8. We also classify among that class in dimensions 7 and 8 those that do not admit a nilsoliton inner product. (Received August 12, 2011)

1075-51-62 **David Alan Glickenstein*** (glickenstein@math.arizona.edu), Department of Mathematics, 617 N Santa Rita, Tucson, AZ 85721. *Flows to find (approximate) Riemann mappings.* Preliminary report.

Thurston's circle packing methods for finding approximate conformal mappings to the disk (solutions guaranteed by the Riemann mapping theorem) are now well-known. The key step in this process is that of taking a circle packing of a domain and then repacking it to a circle packing of the disk with appropriate boundary conditions

(circles are internally tangent to the unit circle). For this reason, the packing problem is solved using hyperbolic geometry, letting boundary circles be horocycles (infinite radius). We investigate alternative boundary conditions with an aim to solve the packing problem using Euclidean geometry, in order to allow for discrete conformal structures other than circle packings. These boundary conditions are natural if one considers a generalization of piecewise Euclidean surfaces that allows for the surface to fold back on itself. This work also begs the question of whether one could use the (smooth) Ricci flow on surfaces with appropriate boundary conditions to solve the Riemann mapping problem. (Received August 19, 2011)

1075-51-66 **Brian T Street***, Department of Mathematics, University of Wisconsin-Madison, 480 Lincoln Dr., Madison, WI 53706. *A Quantitative Frobenius Theorem.*

This talk concerns the classical Frobenius theorem from differential geometry, about involutive distributions. For many problems in harmonic analysis, one needs a quantitative version of the Frobenius theorem. In this talk, we state such a quantitative version, and discuss various applications. (Received August 22, 2011)

1075-51-200 **Jerzy Kocik*** (jkocik@siu.edu), Jerzy Kocik, Department of Mathematics, Southern Illinois University, Carbondale, IL 62901. *The spinor structure of the Apollonian disk packing.*

In the Apollonian disk packings, algebra, geometry, topology and number theory interact in a surprisingly rich way, encompassing Clifford algebras, split quaternions, recurrence sequences, Pythagorean triples, the theory of relativity, etc. We shall present some aspects of the associated spinor structure. (Received August 30, 2011)

52 ► Convex and discrete geometry

1075-52-19 **Mostafa Ghandehari*** (ghandeha@uta.edu), Civil Engineering, University of Texas at Arlington, Box 19308, Arlington, TX 76019. *Erdos-Mordell inequality in the Minkowski plane.* Preliminary report.

In the Euclidean plane Erdos-Mordell inequality indicates that the sum of distances of an interior point of a triangle to vertices is greater than or equal to twice the sum of distances to the sides. A generalization in the Minkowski plane is given. Examples where the unit circles of the Minkowski plane are regular polygons are discussed. (Received July 23, 2011)

53 ► Differential geometry

1075-53-4 **Lei Ni*** (lni@math.ucsd.edu), 9500 Gilman Drive, Department of Mathematics, UC at San Diego, La Jolla, CA 92093. *Gap theorems on Kaehler manifolds.*

A gap theorem concerns, when the curvature of a complete noncompact Riemannian manifold has a sign, what amount of curvature is needed to ensure that the metric is non-trivial (namely nonflat in this case).

In this talk I shall survey on different versions of gap theorems with one started in 1977. The focus shall be placed on various new techniques developed, most often motivated by the study of other subjects in geometric analysis such as the functions of several complex variables, the vanishing theorems in complex geometry, the nonlinear evolution equation including the Ricci flow on complete manifolds, etc, with the goal of proving the sharp results. (Received August 01, 2011)

1075-53-8 **Artem Pulemotov*** (artem@math.uchicago.edu), Department of Mathematics, The University of Chicago, 5734 South University Avenue, Chicago, IL 60637. *Prescribed Ricci curvature on a solid torus.*

We will discuss the prescribed Ricci curvature equation $\mathrm{Ric}(G) = T$ on a solid torus $\mathcal{T}$ under natural boundary conditions. The unknown G here is a Riemannian metric. The letter T in the right-hand side denotes a (0,2)-tensor on $\mathcal{T}$. We will assume T is nondegenerate (in fact, even a lighter assumption would suffice). Our goal will then be to settle the questions of the existence and the uniqueness of solutions in the class of rotationally symmetric Riemannian metrics on a neighborhood of the boundary of $\mathcal{T}$. (Received June 15, 2011)

1075-53-14 **Paul T. Allen*** (ptallen@lclark.edu), Department of Mathematical Sciences, MSC 110, Lewis & Clark College, 0615 SW Palatine Hill Road, Portland, OR 97219, and **K Tsukahara** and **A Layne**. *The Dirichlet problem for the curve shortening flow in convex domains.*

We study the Dirichlet problem for the curve shortening flow in convex regions of the Euclidean plane and round sphere. We establish a version of Huisken's distance comparison estimate on the sphere, which is used to establish global existence for the flow of initially embedded curves. (Received June 30, 2011)

1075-53-24 **Peng Wu*** (wupenguin@math.ucsb.edu), Department of Mathematics, University of California, Santa Barbara, Santa Barbara, CA 93106. *On Potential Function of Gradient Steady Ricci Solitons.*

In this paper, we study the potential function of gradient steady Ricci solitons. We prove that the infimum of the potential function decays linearly. As a consequence, we show that a gradient steady Ricci soliton with bounded potential function must be trivial, and that no gradient steady Ricci soliton admits uniformly positive scalar curvature. (Received August 04, 2011)

1075-53-25 **Ovidiu Munteanu*** (omuntean@math.columbia.edu), 2990 Broadway, New York, NY 10027. *Gradient Ricci Solitons.*

We survey some recent development in the study of Ricci solitons, such as curvature and volume growth estimates or splitting theorems. (Received August 05, 2011)

1075-53-26 **Shihshu Walter Wei*** (wwei@ou.edu), Department of Mathematics, The University of Oklahoma, Norman, OK 73072. *Comparison Theorems, Geometric Flows, And Conservation Laws in p-Harmonic Geometry.*

Many fundamental tools in various branches of mathematics are examples of p-harmonic maps, and they are naturally fused and unified into p-harmonic geometry. In fact, we prove that p-harmonic maps $u : M \to N$ between Riemannian manifolds are generalizations of *geodesics* (when $\dim M = 1$ and u has constant speed), *minimal submanifolds* (when u is an isometric immersion), *logarithmic and exponential functions* (when $p = 1, N = \mathbb{R}, M = \mathbb{R}^+$ and $\mathbb{R}$ respectively), and *conformal maps* (when $p = \dim M = \dim N$), etc. Obviously, when $p = 2$, p-harmonic maps become ordinary harmonic maps. We recall a C^1 map u is said to be *p-harmonic* ($p \geq 1$), if it is a weak solution of the Euler-Lagrange Equation of p-energy functional $E_p(u) = \int_M |du|^p \, dv$, i.e. $div(|du|^{p-2}du) = 0$ on M.

We will study some geometric analytic and geometric measure theoretic aspects of p-harmonic geometry. Some applications and their link to curvature, new comparison theorems in singular differential equations, conservation laws, geometric flows, and monotonicity formula will be discussed. As Further applications, we obtain sharp geometric inequalities and rigidity theorems on Riemannian manifolds. (Received August 06, 2011)

1075-53-30 **Brett Kotschwar*** (kotschwar@math.asu.edu). *Some problems of unique continuation arising in the study of geometric evolution equations.*

We describe some geometric applications of recent work on unique continuation problems for nonlinear weakly-elliptic and weakly-parabolic systems to the study of the Ricci and mean-curvature flows. (Received August 07, 2011)

1075-53-60 **Weiyong He*** (whe@uoregon.edu), Department of Mathematics, University of Oregon, Eugene, OR 97403. *Sasaki Ricci flow and compact Sasaki manifolds with positive transverse bisectional curvature.*

Sasaki geometry, in particular Sasaki-Einstein manifolds has been extensively studied. Sasaki-Riic flow is a suitable tool to study Sasaki manifolds which possibly support Sasaki-Einstein metrics. In this talk we would generalize some results in Kahler geometry and Kahler-Ricci flow to Sasaki setting, in particular including Perelman's results in Kahler-Ricci flow, and positivity in Sasaki setting. (Received August 19, 2011)

1075-53-80 **Bennett Palmer*** (palmbenn@isu.edu), Dept. of Math., Idaho State University, Pocatello, ID 83209. *Anisotropic Surface Energy.* Preliminary report.

We will discuss equilibrium surfaces for a free boundary problem involving anisotropic surfaces energies. We will also discuss a non-local parabolic flow associated with this problem. (Received August 22, 2011)

1075-53-105 **Tracy L. Payne*** (payntrac@isu.edu), Department of Mathematics, Idaho State University, 921 S. 8th Ave., Stop 8085, Pocatello, ID 83209-8085. *Moduli spaces of nilsolitons.*

A nilpotent Lie algebra endowed with an inner product is called em nilsoliton if the corresponding left-invariant metric on the corresponding simply connected nilpotent Lie group is a soliton metric. The most symmetric nilsolitons are algebras of generalized Heisenberg type (these are horospheres in Damek-Ricci spaces). In this talk, we discuss properties of moduli spaces of nilsolitons. We survey results of Heber, Eberlein, Lauret, Nikolayevsky, Jablonski, and Will on moduli spaces. Extending earlier results of Heber, we characterize precisely which algebras of generalized Heisenberg type are isolated in the moduli space of nilsolitons, and we exhibit explicit deformations of those that are not isolated. We also present new geometric invariants that allow us to show that families of nilsolitons have mutually nonisometric elements. (Received August 26, 2011)

1075-53-141 **Xiaodong Cao*** (cao@math.cornell.edu), Department of Mathematics, Cornell University, Ithaca, NY 14853. *Curvature Pinching and Singularities of the Ricci Flow.*

In this talk, we will talk about a pinching estimate and its application to singularity analysis in the study of the Ricci flow. (Received August 26, 2011)

1075-53-209 **Jason Parsley*** (parslerj@wfu.edu). *The geometry of the Taylor problem in plasma physics.*

Plasma injected into a toroidal container loses energy rapidly until it reaches a quasi-stable state while its helicity (an average linking number of its field lines) remains essentially constant. J.B. Taylor showed that by also fixing the flux of the field – assumed divergence free and tangent to the boundary – through a cross-sectional disk, the resulting minimal energy field well approximates experimental results. We consider the problem of Taylor on arbitrary subdomains in R^3. We show a solution always exists and investigate the role of geometry on the problem. (Received August 30, 2011)

1075-53-219 **Roman Smirnov*** (smirnov@mathstat.dal.ca), Department of Mathematics and Statistics, Dalhousie University, Halifax, NS B3H 3J5, Canada, and **Ray McLenaghan** and **Caroline Cochrane**. *Hamilton-Jacobi theory of orthogonal separation of variables on spaces of constant curvature.*

Hamilton-Jacobi theory of orthogonal separation of variables is described within the framework of the invariant theory of Killing tensors, which is an analogue of the classical invariant theory of homogeneous polynomials to obtain a complete solution to the problem of orthogonal separation of variables of the Hamilton-Jacobi equation in 3D-spaces of constant curvature. The solution is based on the underlying ideas of Cartan geometry and ultimately developed into a general new algorithm that can be employed in the study of Hamiltonian systems defined by natural Hamiltonians within the framework of Hamilton-Jacobi theory. (Received August 30, 2011)

55 ► Algebraic topology

1075-55-110 **Rafal Komendarczyk** and **Jeff Pullen*** (jpullen@tulane.edu), Mathematics Department, Tulane University, 6823 St. Charles Ave, New Orleans, LA 70118. *Complete Coverage Probability Via Homology.* Preliminary report.

We address the issue of obtaining the probability of complete coverage for a given domain by a finite coverage process with compact convex grains. In the process, we define homology of a random compact set S and consider a random simplicial complex corresponding to the nerve of a random covering. This allows us to determine the distributions of random Betti numbers as well as the Euler characteristic of S. Armed with these notions, we address the probability of complete coverage of domains which have a homotopy type of a simplicial complex which has potential applications in the area of sensor networks. (Received August 25, 2011)

1075-55-214 **Gregory R Conner*** (greg.conner@gmail.com), Greg Conner, 292-A TMCB, BYU, Provo, UT 84602. *Some open questions on fundamental groups of low-dimensional wild spaces.* Preliminary report.

We'll discuss some interesting, hard questions concerning fundamental groups of 1-dimensional spaces, planar sets and subspaces (often submanifolds) of $\mathbb{R}^3$. The talk will start with a list of some interesting known results and then we'll move on to the open problems, discussing how they are related to the known results, why they are interesting and why they should be true. (Received August 30, 2011)

57 ► Manifolds and cell complexes

1075-57-77 **Jozef H. Przytycki*** (przytyck@gwu.edu), Department of Mathematics, George Washington University, Washington, DC 20052, and **Krzysztof Putyra**. *Homology of distributive lattices: splitting chain complexes.*

For a set X we consider a monoid of binary operations $Bin(X)$. The composition of operations $*_1*_2$ is defined by $a *_1 *_2 b = (a *_1 b) *_2 b$ and the identity $*_0$ is given by $a *_0 b = a$. We say that the set $\{*_1, ..., *_k\}$ of binary operations is called a distributive set if all pairs of elements $*_i, *_j$ are right distributive The pair $(X; \{*_1, ..., *_k\})$ is called a multi-shelf.For a multi-shelf we define a multi-term homology $H_n^{(a_1,..,a_k)}(X)$ as follows. We define $C_n(X) = ZX^{n+1}$ and $\partial_n^{(*)}(x_0, , , , , x_n) = \sum_{i=0}^{n}(-1)^i(x_0 * x_i, ..., x_{i-1} * x_i, x_{i+1}, ..., x_n)$. The boundary operation of of the multi-term chain complex $(C_n(X), \partial^{(a_1,..,a_k)})$ is $\partial^{(a_1,..,a_k)} = \sum \partial^{(*_i)}$. We compute 4-term homology of finite distributive lattice $(L, *_\cup, *_\cap)$. We consider the 4-element distributive set (monoid): $\{*_0, *_\cup, *_\cap, *_\sim = *_\cap *_\cup\}$. The first part of our work is to split our chain complex into three subcomplexes: $C(X) = C(t) \oplus F^0(X, t) \oplus C(X)/(F^0 \cup C(t)$, where $C(t)$. Then we analyze each ingredient separately (this will be discussed in the second part of the talk). (Received August 22, 2011)

1075-57-127 **Jing Wang*** (gwjwang@gwmail.gwu.edu), Department of Mathematics, George Washington University, 2115 G Street NW, Washington, DC 20052. *Homology of a Small Category with Functor Coefficients and Barycentric Subdivision.*

We analyze the classical result that barycentric subdivision preserves homology, and then generalize it to the context of a small category with coefficients in a functor to R-modules. (Received August 25, 2011)

1075-57-239 **Violeta Vasilevska*** (Violeta.Vasilevska@uvu.edu), 800 W University Parkway, Orem, UT 84058. *Shape m_{simpl} Fibrators among Products of Hopfian manifolds.* Preliminary report.

In this talk, we discuss which direct products of Hopfian manifolds are shape m_{simpl} fibrators (manifolds that can "detect" approximate fibrations in a special PL setting). In addition, we introduce a particular type of Hopfian group and discuss its properties. It will be shown how important these special groups are as fundamental groups of the shape m_{simpl} fibrators discussed. (Received August 30, 2011)

58 ► Global analysis, analysis on manifolds

1075-58-49 **Gerard Misiolek*** (gmisiole@nd.edu). *Spherical geometry of $\mathcal{D}^s(M)/\mathcal{D}^s_\mu(M)$.*

I will describe the geometry of an H^1 Sobolev metric on the homogeneous space $\mathcal{D}^s(M)/\mathcal{D}^s_\mu(M)$ and the properties of the associated Euler-Arnold equation as well as connections to statistics. (Received August 16, 2011)

1075-58-139 **Nathan Smale*** (smale@math.utah.edu), Department of Mathematics, University of Utah, Salt Lake City, UT 84112. *A Metric Hodge Theory for Alexandrov Spaces with Curvature Bounded Above.*

In previous work with L. Bartholdi, T. Schick and S. Smale, a Hodge theory for compact metric spaces with a probability measure, based on the Alexander-Spanier co-boundary operator was proposed. The corresponding cohomology quantifies topological structures that can be seen at a fixed scale. It was also shown that the theory holds for compact Riemannian manifolds. Here we will discuss a recent result that extends this to compact Alexandrov spaces with curvature bounded from above. (Received August 26, 2011)

60 ► Probability theory and stochastic processes

1075-60-101 **James L Carroll*** (jlcarroll@lanl.gov), 1126 Cheyenne St., Los Alamos, NM 87544. *Turning Bayesian Model Averaging Into Bayesian Model Combination.*

Bayesian model averaging is generally considered the standard model for creating ensembles of learners using Bayesian methods, but this technique is often outperformed by more ad hoc methods in empirical studies. The reason for this failure has important theoretical implications for our understanding of why ensembles work. It has been proposed that Bayesian model averaging struggles in practice because it accounts for uncertainty about which model is correct but still operates under the assumption that only one of them is. In order to more effectively access the benefits inherent in ensembles, Bayesian strategies should therefore be directed more towards model combination rather than the model selection implicit in Bayesian model averaging. This work provides empirical verification for this hypothesis using several different Bayesian model combination approaches tested on

a wide variety of classification problems. We show that even the most simplistic of Bayesian model combination strategies outperforms the traditional ad hoc techniques of bagging and boosting, as well as outperforming BMA over a wide variety of cases. (Received August 24, 2011)

62 ► Statistics

1075-62-104 **Thomas A Beery***, Thomas Beery, Los Alamos National Laboratory, Mail Stop P912, Los Alamos, NM 87545. *Reconstructing Tilted, Axis-Symmetric Objects from Radiographs.* Preliminary report.

When the axis of symmetry of an object is parallel to the image plane, the discrete Abel inverse can be used for reconstruction. For tilted objects, this is not possible. Results based on Conjugate Gradient Least Squares and Singular Value Decomposition are presented. Implications for the Adjoint Method are discussed. (Received August 24, 2011)

65 ► Numerical analysis

1075-65-6 **J. Ding***, Department of Mathematics, University of Southern Mississippi, Hattiesburg, MS 39406, and **N. Rhee**, Department of Mathematics and Statistics, University of Missouri atKansas City, Kansas City, MO 64110. *On the BV-Norm convergence of a piecewise linear projection method for Markov operators.*

Using linear algebra and variation arguments, we prove the BV-norm convergence for a piecewise linear Galerkin projection method for computing stationary densities of Markov operators that satisfy the Lasota-Yorke inequality. We also give a convergence rate analysis under the BV-norm. (Received May 03, 2011)

1075-65-67 **Jonathan D Hauenstein*** (jhauenst@math.tamu.edu), Department of Mathematics, Mailstop 3368, Texas A&M University, College Station, TX 77845-3368, and **Viktor Levandovskyy** (Viktor.Levandovskyy@math.rwth-aachen.de), RWTH Aachen University, Templergraben 64, D-52062 Aachen, Germany. *Certifying solutions to systems of polynomial-exponential equations.*

Polynomial-exponential systems are systems of analytic functions which are polynomial in both the variables and finitely many exponentials. Such systems naturally arise from modeling compliant mechanisms and in electrical engineering. In this talk, I will discuss recent work with V. Levandovskyy regarding the development of an effective criterion using Smale's α-theory to certify solutions. Examples using the software package alphaCertified will demonstrate the new approach. (Received August 22, 2011)

1075-65-81 **George Hsiao**, **Fengshan Liu** and **Jiguang Sun*** (jsun@desu.edu), ETV 227, Delaware State University, 1200 N. DuPont Hwy., Dover, DE 19901, and **Liwei Xu**. *A coupled BEM and FEM for the interior transmission problem.*

The interior transmission problem (ITP) is a boundary value problem arising in inverse scattering theory, and it has important applications in qualitative methods. In this talk, we employ a coupled boundary element method (BEM) and a finite element method (FEM) for the ITP in two dimensions. The coupling procedure is realized by applying the direct boundary integral equation method to define the so-called Dirichlet-to-Neumann (DtN) mappings. We show the existence of the solution to the ITP for the anisotropic medium. Numerical results are provided to demonstrate the accuracy of the coupling method. (Received August 22, 2011)

1075-65-83 **X. Jiang**, **L. Zhang** and **W. Zheng*** (zwy@lsec.cc.ac.cn), No. 55, ZhongGuanCun East Road, Haidian District, P.O. Box 2719, Beijing, 100190, Peoples Rep of China. *On hp-adaptive finite element methods for time-harmonic Maxwell's equations.*

In this lecture, I am going to talk about hp-adaptive finite element methods for time-harmonic Maxwell's equations. We propose two *hp*-adaptive algorithms using residual-based a posteriori error estimates and unstructured tetrahedral meshes. Extensive numerical experiments are reported to investigate the efficiency of the *hp*-adaptive methods for point singularities, edge singularities, and an engineering benchmark problem. By large-scale computations based on MPI, we obtain exponential decay of the error with respect to the number of degrees of freedom for all the experiments. (Received August 23, 2011)

1075-65-88 **Jianlong Han** (han@suu.edu), Cedar City, UT 84720, and **Sarah M Brown*** (brown_s@suu.edu), Cedar City, UT 84720. *Numerical analysis for the relaxation of a nonlocal Allen-Cahn equation.* Preliminary report.

We study the existence, uniqueness and continuous dependence on initial data of the solution for relaxation of a nonlocal Allen-Cahn equation on a bounded domain. The equation is the relaxation of a gradient flow for a free energy functional with nonlocal interaction. Also we do the numerical analysis for this equation. (Received August 23, 2011)

1075-65-94 **Xiao-Chuan Cai*** (cai@cs.colorado.edu), Department of Computer Science, University of Colorado at Boulder, Boulder, CO 80309. *Parallel Fluid-Structure Interaction Algorithms for Simulation of Blood Flow in Artery.*

We discuss a parallel domain decomposition algorithm for the simulation of blood flows in compliant arteries using a fully coupled system of nonlinear partial differential equations consisting of a linear elasticity equation and the incompressible Navier-Stokes equations. The system is discretized with a finite element method on unstructured moving meshes and solved by a Newton-Krylov algorithm preconditioned with an overlapping restricted additive Schwarz method. We also discuss the parallel performance of the implicit domain decomposition method for solving the fully coupled nonlinear system on a supercomputer with a large number of processors. This is a joint work with A. Barker and Y. Wu. (Received August 23, 2011)

1075-65-99 **Alexander V Mamonov*** (mamonov@ices.utexas.edu), 1 University Station C0200, Austin, TX 78712, and **Liliana Borcea**, **Vladimir Druskin** and **Fernando Guevara Vasquez**. *Resistor networks and optimal grids for electrical impedance tomography with partial boundary measurements.*

In EIT with partial boundary measurements we determine the conductivity inside an object from the measurements of currents and voltages on a subset of its boundary. We regularize the ill-conditioned problem using resistor network models corresponding to discretizations on adaptive (optimal) grids. Two approaches implement this strategy.

The first approach uses the results for the full boundary measurements case, which rely on the use of circular resistor networks. The optimal grids in this case can be computed explicitly. The partial data problem is reduced to the full data case using extremal quasiconformal mappings.

The second approach is based on resistor networks with special graph topology. Pyramidal networks are used for the one-sided problem and two-sided networks are used for the two-sided case. The optimal grids are computed using the sensitivity analysis of the continuum and discrete EIT problems.

The numerical results show two main advantages of our approaches compared to optimization-based methods. First, network based inversion is orders of magnitude faster than any iterative algorithm. Second, our approaches correctly reconstruct the conductivities of very high contrast, which typically present a challenge to the traditional inversion methods. (Received August 24, 2011)

1075-65-128 **Yekaterina Epshteyn*** (epshteyn@math.utah.edu), University of Utah, Department of Mathematics, Salt Lake City, UT 84112, and **S. Bryson**, **A. Kurganov** and **G. Petrova**. *Well-Balanced Positivity Preserving Central-Upwind Scheme on Triangular Grids for the Saint-Venant System.*

We introduce a new second-order central-upwind scheme for the Saint-Venant system of shallow water equations on triangular grids. We prove that the scheme both preserves "lake at rest" steady states and guarantees the positivity of the computed fluid depth. Moreover, it can be applied to models with discontinuous bottom topography and irregular channel widths. We demonstrate these features of the new scheme, as well as its high resolution and robustness in a number of numerical examples. (Received August 26, 2011)

1075-65-129 **Jichun Li** (jichun@unlv.nevada.edu) and **Jiajia Wang*** (wangj16@unlv.nevada.edu), Dept of Mathematical Sciences, University of Nevada Las Vegas, Las Vegas, NV 89154-4020, and **Eric Machorro** (MachorEA@nv.doe.gov). *A leap-frog discontinuous Galerkin method for the time-domain Maxwell's equations in metamaterials.*

Numerical simulation of metamaterials play a very important role in the design of invisibility cloak, and sub-wavelength imaging. In this talk, we will discuss a leap-frog discontinuous Galerkin method for solving the time-dependent Maxwell's equations in metamaterials. Conditional stability and error estimates are proved for the scheme. Implementation of the proposed algorithm and numerical results supporting the analysis will be presented. (Received August 26, 2011)

1075-65-130 **Jichun Li*** (jichun@unlv.nevada.edu), Dept of Mathematical Sciences, University of Nevada Las Vegas, Las Vegas, NV 89154-4020. *Time-domain finite element modeling of wave propagation in metamaterials.*

Since 2000, there is a growing interest in the study of metamaterials due to their applications in areas such as design of invisible cloak and sub-wavelength imaging. In this talk, I'll first give a brief overview on metamaterials with some interesting applications of metamaterials conducted by engineers and physicists. Then I'll talk about some recently developed time-domain finite element (TDFEM) methods for metamaterial simulation. Finally, some interesting numerical results and open issues will be presented. (Received August 26, 2011)

1075-65-175 **Malgorzata Peszynska*** (mpesz@math.oregonstate.edu), Department of Mathematics, Oregon State University, Corvallis, OR 97331. *Numerical approximation of scalar conservation law with hysteresis, relaxation, and double-porosity.*

A numerical scheme for a scalar conservation law can be used in a constructive way to define entropy solutions to such equations. In the talk we discuss conservation laws arising in applications to methane evolution and carbon sequestration in coalbeds where models of hysteresis, relaxation, and double-porosity enhance a classical conservation law model with a convex flux term.

We first consider an initial value problem for a scalar conservation law with hysteresis which is represented via an auxiliary monotone coupling or a family of such couplings. We define a numerical scheme for such a law, prove its stability, and discuss the context in which it is consistent. The scheme can be fully implicit, or its regularization can be explicit, and there are advantages and disadvantages of both approaches.

Next we discuss a broader context arising in the applications in coalbeds where the additional terms complicate the analysis. (Received August 29, 2011)

1075-65-195 **Mikhail Y Zaslavsky*** (mzaslavsky@slb.com), 1 Hampshire str, Cambridge, MA 02139, and **Vladimir L Druskin** and **Valeria Simoncini**. *Solution of the time-domain inverse resistivity problem in the model reduction framework.*

In this work we consider the model reduction approach based on the Rational Krylov subspace (RKS) projection method. We derive a representation for the reduced Jacobian as the product of a time-dependent and a stationary part. We show that the RKS satisfying the Meier-Luenberger necessary H_2 (Hardy space) optimality condition not only minimizes the approximation error but completely annuls its influence on the inversion result (even if the subspace is not optimal globally). More precisely, the approximation error belongs to the (left) null-space of the reduced Jacobian. We compare inversion on such subspaces using other nearly optimal RKS's based on Zolotarev problem and adaptive pole selection algorithm. (Received August 29, 2011)

1075-65-224 **Frank Stenger*** (stenger@cs.utah.edu). *Approximating Indefinite Convolutions.*

The two integrals integrals defined on $(a,b) \subset \mathbb{R}$

$$p(x) = \int_a^x f(x-t)g(t)dt,\ q(x) = \int_x^b f(t-x)g(t)dt \tag{1}$$

arise in many areas of analysis and applications, such as control theory, Volterra integral equations, fractional integrals, integrodifferential equations, etc. Using the operator notations

$$(J^+g)(x) = \int_a^x g(t)\,dt,\ (J^-g)(x) = \int_x^b g(t)\,dt, \tag{2}$$

and the "Laplace transform" formula

$$F(s) = \int_0^c e^{-t/s}\,f(t)\,dt, \Re s > 0,\ c \geq (b-a), \tag{3}$$

(1) becomes

$$p = F(J^+)g,\ q = F(J^-)g, \tag{4}$$

This talk presents some new identities made possible via (4), such as Laplace transform inversion, $f = (J^+)^{-1}F(J^+)1$, the Hilbert transform, $Hg = (\log J^- \log J^+)g$, and for solving Wiener-Hopf equations, $f(x) + \int_0^\infty k(x-t)\,f(t)\,dt = g(x), \quad x \in (0,\infty)$. These identities and the formulas (4) can be accurately approximated using known methods for approximating the integrals (2). The talk also presents a new way of evaluating (4), and the use of the identities (4) together with the approximations of the integrals (2) to enable novel efficient methods that do not require the use of large matrices for solving partial differential equations. (Received August 30, 2011)

1075-65-231 **Elena Cherkaev*** (elena@math.utah.edu). *Matrix Pade approximants of the spectral function of composites.*

The talk discusses reconstruction of the spectral measure in the Stieltjes integral representation of the effective properties of composite materials using Pade approximation. We consider a case of matrix valued measure

corresponding to anisotropic composites. Matrix Pade approximants are derived using matrix polynomials orthogonal with respect to the spectral function. We discuss applications to inverse homogenization theory and to numerical simulation of propagation of waves in composites. (Received August 30, 2011)

1075-65-247 **Jie Shen*** (shen7@purdue.edu), Department of Mathematics, Purdue University, West Lafayette, IN 47906. *Efficient and Stable Spectral Methods for Scoustic and Electromagnetic scattering.*

I shall present an efficient and stable spectral algorithm and their numerical analysis for the Helmholtz and Maxwell equations in both two- and three-dimensional in exterior domains or in periodic layered media. The algorithm couples a boundary perturbation technique with a well-conditioned spectral-Galerkin solver based on the Dirichlet-to-Neumann operator. Error analysis with explicit dependence on the wave number as well as ample numerical results will be presented to show the accuracy, stability, and versatility of this algorithm. (Received August 31, 2011)

68 ► Computer science

1075-68-18 **Hanna E Makaruk*** (hanna_m@lanl.gov), MS D410, P-21, Los Alamos National Laboratory, Los Alamos, NM 87545, and **Robert M. Owczarek** (owczarek@hughes.net), 59 Coryphodon Ln, Jemez Springs, NM 87025. *Generalization of inverse Abel transform for shifted reconstruction axis.* Preliminary report.

Inverse Abel Transform method is widely used in reconstruction of 3D objects from their radiographic images. This mathematical transformation assumes exact axial symmetry of the object, yet it produces results also in cases when this assumption is not fulfilled. Unfortunately the deviation from strict symmetry is not uncommon in experimental radiographs, and results obtained in such way would have built in substantial systematic error. Two types of such errors are discussed. One parameter families of non-axially symmetric objects that create identical image that can be misinterpreted as unique axially symmetric image are the first one. The number of radiographic projections required to make reconstruction unique is discussed. Shift of the reconstruction axis in comparison to the symmetry axis of the object is the second case. Analytical formulas as well as numerical plots are presented to show reconstruction of a sphere as a function of shift of the symmetry axis, and difference of such reconstruction from the non-shifted one. Understanding these phenomena leads to generalization of Abel inversion: proper reconstruction of shapes and densities in cases when the symmetry assumption is not strictly fulfilled. (Received July 19, 2011)

1075-68-58 **Simina Branzei*** (simina.branzei@gmail.com), Strada Prieteniei, Nr 74, Bacau, Romania, and **Tomasz Michalak**, **Talal Rahwan**, **Kate Larson** and **Nicholas Jennings**. *Matching Problems with Compact Externalities: A Stability Analysis.* Preliminary report.

Two-sided matchings are an important theoretical tool used to model markets and social interactions. In many real life problems the utility of a player is influenced not only by their own choices, but also by the choices that other players make. Such an influence is called an externality. Whereas fully expressive representations of externalities in matchings require exponential space, in this paper we propose the first compact model of externalities, in which the influence of a match on each player is computed additively. In this framework, we define a general stability concept that takes into account externalities. Then we focus on several instantiations of this stability concept in the context of many-to-many and one-to-one matchings under neutral, optimistic, and pessimistic behaviour, and provide both computational hardness results and polynomial-time algorithms for computing stable outcomes. (Received August 18, 2011)

1075-68-218 **Brian G Stafford*** (stafford@lanl.gov), Brian G. Stafford, 3015 Siringo Rd., Santa Fe, NM 87507-5038. *Category Theory for Inferring the Shape of a Light Source From an Optimized Model of its Shadow.* Preliminary report.

The unknown shape of a light source is determined by optimizing a rotated polynomial reciprocal whose origin symmetry is disrupted by four shaping parameters. These shaping parameters adjust a blurring convolution matrix representing the light source distribution. Shadow edges are determined by the blurring convolution. A 'U' shaped category theory diagram provides the context for the inverse problem of finding light source shaping parameters from the blurred shadow edges in image data. The first side of the 'U' registers the position and scale of image data to the model of a known target object in the image. The second side of the 'U' transforms a geometric model of the target to account for known effects of optical elements, adsorption, and detector blur

along with the unknown shape of the light source distribution. The bottom of the 'U' compares data and model paths, providing a fitness function for optimizing all variables in the diagram. (Received August 31, 2011)

70 ► Mechanics of particles and systems

1075-70-28 **Manuele Santoprete*** (msantopr@wlu.ca), Department of Mathematics, Wilfrid Laurier university, 75 University Avenue West, Waterloo, Ontario N2L 3C5, and **Marshall Hampton** and **Gareth Roberts**. *Relative equilibria in the four vortex problem with two pairs of equal vorticities.* Preliminary report.

The N-vortex problem concerns the dynamics of N point vortices moving in the plane. Of particular interest in this problem are solutions that appear fixed when viewed in an uniformly rotating frame. Such solutions are called relative equilibria. In this presentation we describe a complete classification of the relative equilibria in the four vortex problem with two pairs of equal vorticities. (Received August 07, 2011)

1075-70-70 **Skyler C Simmons*** (xinkaisen@gmail.com), 275 TMCB, Brigham Young University, Provo, UT 84602. *A new family of linearly stable periodic simultaneous binary collision orbits in the two-dimensional four-body problem.*

Recently, periodic orbits involving collisions between pairs of bodies have been receiving more and more attention. Beginning with a periodic three-body equal-mass collinear orbit established numerically by Schubart (1956), there have been many papers establishing results of unequal-mass variations of this orbit, including linear stability (Hietarinta & Mikkola 1993, Saito & Tanikawa 2007, 2009, 2010) and analytic existence (Venturelli 2008, Moeckel 2008, Shibayama 2011). A four-body collinear variation of this orbit was discovered numerically (Sweatman 2002, Sekiguchi & Tanikawa 2004). Numerical linear stability for this orbit has also been established (Sweatman 2006) as well as analytic existence (Ouyang & Yan, 2011).

In this presentation, we will show a class of two-dimensional periodic orbits of four bodies with simultaneous binary collisions between the masses. We will begin by showing the four-body orbit with equal masses and provide an outline of the analytic proof of its existence. We will then show the symmetric mass case, wherein the masses are symmetric with respect to a 180-degree rotation about the origin. Lastly, we will introduce the stability technique of Roberts and show its application to our problem, demonstrating stability for an interval of mass ratios. (Received August 22, 2011)

1075-70-97 **Alexander Panchenko*** (panchenko@math.wsu.edu). *Deconvolution closure for spatially averaged dynamics of particle systems.* Preliminary report.

The main question addressed in the talk is how to obtain closed form continuum equations governing spatially averaged dynamics of many-particle systems. The underlying particle dynamics is modeled by the classical Newton ODEs. The starting point is the system of the balance equations derived by Noll, Hardy, Murdoch and others. The missing ingredient in these works is closure: the equations are exact but calculation of fluxes requires solving the underlying ODE system. To produce continuum equations that can be simulated without resolving particle dynamics, we developed a closure method based on the use of regularized deconvolutions. We also present results of numerical experiments showing good agreement between the closed form flux approximations and their exact counterparts. (Received August 23, 2011)

1075-70-100 **Elizabeth Zollinger*** (zollingerea@hiram.edu), 11715 State Route 700, Hiram, OH 44234. *Minimizing Orbits in the Equal Mass 3-Body Problem as Seen on the Shape Sphere.* Preliminary report.

Using variational techniques, we will examine the family of comet orbits for the 3-body problem. First we find the minimizing orbit of the curves which start collinear and end isosceles and then we consider how moving the angle of rotation leads to a family of orbits on the shape sphere. For this talk we will examine the topology of the orbits on the sphere. (Received August 24, 2011)

1075-70-174 **Lennard F Bakker*** (bakker@math.byu.edu), Department of Mathematics, Brigham Young University, Provo, UT 84602. *Reinterpretation of Regularization of Collisions through Real Algebraic Geometry.* Preliminary report.

Regularization of binary and/or simultaneous binary collisions in the collinear N-body problem is a common tool used to analyze the geometry of orbits near these kinds of singularities. The Levi-Civita type coordinate and time transformations typically used in regularization are reinterpreted in terms of real algebraic geometry. This reinterpretation applies to Hamiltonians whose potential part is a finite sum of reciprocals of homogeneous polynomials in the position coordinates. (Received August 29, 2011)

1075-70-192 **Cristina Stoica*** (cstoica@wlu,ca), Department of Mathematics, Wilfrid Laurier University, Waterloo, Ontario N2L 3C5, Canada. *Symmetric mechanical systems with configuration space isotropy.*

This talk concerns Lagrangian symmetric systems near points with configuration space isotropy. A prototypical example is given by $SO(3)$invariant mass-point systems in collinear configurations.

Using twisted parametrisations corresponding to phase space slices based at zero points of tangent fibres, we deduce the reduced equations of motion, which are a hybrid of Euler-Poincaré and Euler-Lagrange equations. We further specialize these equations to the case of systems of the form kinetic plus potential. (Received August 29, 2011)

74 ► Mechanics of deformable solids

1075-74-13 **Alexey Miroshnikov*** (amiroshn@math.umd.edu) and **Athanasios Tzavaras** (tzavaras@tem.uoc.gr). *A variational approximation scheme for radial polyconvex elasticity that excludes interpenetration of matter.*

The equations of elastodynamics is a system of conservation laws that describes the evolution of an elastic body expressed by the motion $y(x,t)$. In general, the stored energy function $W(\nabla y)$ and hence the entropy $\eta(v,\nabla y) = \frac{v^2}{2} + W(\nabla y)$ are not convex which causes various difficulties in applying the general theory of conservation laws.

It turns out that elastodynamics with polyconvex stored energy can be embedded into a larger symmetric hyperbolic system and visualized as constrained evolution leading to a variational scheme. This was explored earlier by S. Demoulini, A. Tzavaras and D. Stuart for three dimensional elastodynamics. The above results do not take into account the constrain that a physically realizable motion $y(x,t)$ must satisfy $\det \nabla y > 0$ which ensures that material cannot be compressed into a point.

We study radial elastodynamics for isotropic elastic materials. We present an enlarged system with additional transport identities associated with null-Lagrangians and construct a variational scheme that decreases the total mechanical energy and at the same time leads to physically realizable motions that avoid interpenetration of matter. (Received June 30, 2011)

1075-74-119 **Yury Grabovsky*** (yury@temple.edu), **Vladislav A Kucher** (kucher-va@yandex.ru) and **Lev Truskinovsky** (trusk@lms.polytechnique.fr). *On instabilities of smooth phase boundaries in non-linearly elastic solids.*

Different notions of elastic stability can be applied to phase boundaries. One of them, positivity of the generalized second variation, first computed explicitly by Grinfeld, will be discussed in detail. We extend Grinfeld's work to general energy densities, as well as simplify the final formula. We then apply the method in the example with bi-quadratic elastic energy and prove an instability result that cannot be obtained by any other method. (Received August 25, 2011)

1075-74-126 **M. Yvonne Ou*** (mou@math.udel.edu), Department of Mathematical Sciences, University of Delaware, Newark, DE 19716. *Two-parameter Integral Representation Formula for the Effective Elastic Moduli of Two-phase Composites.*

In this talk, we will present the integral representation formula for two-phase elastic composites and its implications. The numerical aspects of computation of effective properties of real-world composites such as cancellous bones will be discussed. We will also show the numerical results of the algorithm which we proposed recently. (Received August 25, 2011)

76 ► Fluid mechanics

1075-76-35 **Benjamin Akers*** (Benjamin.Akers@afit.edu) and **Wenxuan Gao**. *Wilton ripples in weakly nonlinear models.*

A numerical method for computing Wilton ripples and other short crested solutions to a family of model equations is described. The family of equations includes the 5th-order KdV equation, as well as other weakly nonlinear geophysical models. The method is perturbative, and provides the framework to study the analyticity of solutions, both rigorously and numerically. Numerically computed wave profiles and branches are presented. (Received August 12, 2011)

1075-76-79 **Sarah D Olson*** (sdolson@wpi.edu) and **Lisa J Fauci**. *Hydrodynamic Interactions of Hyperactivated Sperm.*

Hyperactivated sperm motility is correlated to an increase in calcium concentration within the flagellum and is characterized by highly asymmetrical waveforms and circular trajectories. Previous computational studies of flagellum with symmetrical waveforms have shown that multiple sperm swimming with waveforms that are out of phase will eventually phase lock due to hydrodynamic interactions. The focus of this research is to study the hydrodynamic interactions of hyperactivated sperm swimming in proximity in both an unbounded fluid domain and near a wall. (Received August 22, 2011)

1075-76-144 **Jerry L. Bona*** (bona@math.uic.edu), Dept. Math. Statistics & Computer Science, University of Illinois at Chicago, 851 S. Morgan Street MC 249, Chicago, IL 60607. *The Hirota-Satsuma Equation as a Model for Shallow Water Waves.* Preliminary report.

The Hirota-Satsuma equation was formally derived as a model for long waves of small amplitude propagating on the surface of a layer of incompressible, irrotational perfect fluid. Recently, Iorio, Pilod and the author have put forward rigorous theory for this slightly odd looking evolution equation. This theory is reviewed and it is further indicated that the model does indeed approximate appropriately sized, long-crested solutions of the full water wave problem. (Received August 27, 2011)

1075-76-169 **Thomas Hagen*** (thagen@memphis.edu), Dunn Hall 367, Department of Mathematical Sciences, The University of Memphis, Memphis, TN 38152. *Analytical aspects in the theory of free liquid fibers and sheets.*

Models of thin free liquid jets and sheets considered here are based on two assumptions: thinness of the fiber/film and dominant viscous forces. As a result of these assumptions the governing equations for these flows take on the form of a system of nonlinear coupled elliptic–hyperbolic partial differential equations. They represent formal asymptotic limits of the full Navier-Stokes equations with free surface.

In this presentation we will address recent analytical results in the theory of free liquid fibers and sheets, primarily pertaining to fiber spinning and film casting. Central themes will be the existence and stability of equilibrium solutions and global existence results. (Received August 29, 2011)

1075-76-191 **Robert M Owczarek*** (owczarek@hughes.net), 59 Coryphodon Ln, Jemez Springs, NM 87025. *Recent results in fluid mechanics.* Preliminary report.

I will present some recent results in fluid mechanics. (Received August 29, 2011)

1075-76-228 **Peter Vorobieff*** (kalmoth@unm.edu), The University of New Mexico, MSC01 1150, Albuquerque, NM, and **Michael Anderson**, **Joseph Conroy**, **Ross White**, **Patrick Wayne**, **Sanjay Kumar** and **C. Randall Truman**. *Particle lag instability.*

We describe an instability that develops in multiphase flows where a small volume fraction of the medium (e.g., gas or plasma) is occupied by the embedded phase (particles, drops, etc.). If the distribution of that embedded phase is non-uniform, so is the average density, and acceleration (constant or impulsive) of the medium with the embedded phase results in vortex formation, in a fashion somewhat similar to vortex roll-up due to the well-known Rayleigh-Taylor and Richtmyer-Meshkov instabilities. The latter, however, develop on a density interface (sharp or diffuse) between single-phase media of different densities. The physical mechanism responsible for the new instability appears quite different, in particular, in the case of impulsive acceleration, where particles or droplets lag behind the accelerated gas (or plasma), with the resulting momentum exchange between the phases responsible for production of shear and thus for vortex roll-up. (Received August 30, 2011)

1075-76-233 **Aleksey S Telyakovskiy*** (alekseyt@unr.edu), Department of Mathematics and Statistics, University of Nevada, Reno, NV 89557. *Approximate solution for groundwater flows.* Preliminary report.

The Boussinesq equation describes water flows in unconfined groundwater aquifers under the Dupuit assumption that the equipotential lines are vertical, making flow horizontal. It is a nonlinear diffusion equation with diffusivity depending linearly on water head. The generalized Boussinesq equation or porous medium equation is an equation where the diffusivity is a power law function of water head. For certain types of initial and boundary conditions similarity reduction is possible. Here we construct approximate analytical solutions that respect the scaling properties of the equations. (Received August 30, 2011)

1075-76-236 **Roberto Camassa**, **Claudia Falcon**, **Zhi Lin**, **Richard McLaughlin** and **Keith Mertens*** (mertens@email.unc.edu), University of North Carolina, Department of Mathematics, Phillips Hall CB 3250, Chapel Hill, NC 27599, and **David Nenon**, **Casey Smith**, **Bailey Watson** and **Brian White**. *Entrapment phenomena of buoyant fluids passing through sharply stratified density transitions.*

With motivation coming from the recent Gulf Oil spill, questions arose concerning when/if trapping of buoyant fluids can occur due to underlying sharp stratification. In this talk, experimental results will be presented concerning when emulsified oil plumes, micro-particle jets, and dense vortex rings can be trapped when passing through sharply stratified density transitions. Connections will be drawn between these continuous sourcing jets and the initial release of a finite volume fluid droplet. A critical length scale is shown to exist for which complete entrapment can occur in these settings. Scaling arguments will be given to understand this critical length scale for each case. In the case of plumes and jets, an exact solution will also be shown, and compared to experiments, which predicts this critical length scale coming from classical Morton Turner Taylor theory. (Received August 30, 2011)

1075-76-237 **H. Reed Ogrosky*** (ogrosky@email.unc.edu), **Roberto Camassa**, **M. Gregory Forest**, **Long Lee**, **John Mellnik** and **Jeffrey Olander**. *Ring-waves as a mass transport mechanism in air-driven core-annular flow.*

We design an experiment to emulate mucus movement by an air-driven vertical flow of high-viscosity silicone oil through a thin glass tube. When a constant flux of air is delivered through the bottom of the tube, instabilities arise, generating upward moving waves at the oil/air interface. These constitute a main mechanism of momentum transfer from air to oil, whereby oil is transported upward against gravity. We test this mechanism with several different flow rates of both air and oil. We also develop a long-wave model and numerically study solutions of the resulting evolution equation for the location of the air-oil interface. The numerical results are compared with the model in several ways; in particular we study under what conditions the waves are mass transport waves. A second experiment is designed to confirm this striking feature of the air-driven core-annular flow. (Received August 30, 2011)

78 ► Optics, electromagnetic theory

1075-78-44 **Arnold D Kim*** (adkim@ucmerced.edu), School of Natural Sciences, 5200 North Lake Road, Merced, CA 95340. *Modeling polarization-resolved measurements of light scattered by tissues.*

We study partially polarized light propagation in tissues governed by the vector radiative transport equation. In particular, we derive an asymptotic solution in the strong scattering and weak absorption limit. This asymptotic solution provides an accurate model for boundary measurements. We evaluate the effectiveness of this asymptotic solution through comparison with the numerical solution of the full problem. (Received August 15, 2011)

1075-78-51 **Alexander Figotin*** (afigotin@uci.edu), Mathematics Department, University of California at Irvine, Irvine, CA 92697. *Title: Some Mathematical Problems in a Neoclassical Theory of Electric Charges.*

We study a number of mathematical problems related to our recently introduced neoclassical theory for electromagnetic phenomena in which charges are represented by complex valued wave functions as in the Schrodinger wave mechanics. In the non-relativistic case the dynamics of elementary charges is governed by a system of nonlinear Schrodinger equations coupled with the electromagnetic fields, and we prove that if the wave functions of charges are well separated and localized, then their centers converge to trajectories of the classical point charges governed by Newton's equations with the Lorentz forces. We also found exact solutions in the form of localized accelerating solitons. Our studies of a class of time multiharmonic solutions of the same field equations show that they satisfy Planck-Einstein relation and that the energy levels of the nonlinear eigenvalue problem for the hydrogen atom converge to the well-known energy levels of the linear Schrodinger operator when the free charge size is much larger than the Bohr radius. (Received August 17, 2011)

1075-78-154 **Hongyu Liu*** (hliu28@uncc.edu), Department of Mathematics and Statistics, University of North Carolina, Charlotte, NC 28263. *Enhance Approximate Cloaking by SH and FSH Lining.*

In this talk, we shall report our recent study on approximate cloaking from a regularization viewpoint for the Helmholtz equation. We shall show that by employing a sound-hard (SH) layer between the cloaked region and the cloaking region, one could achieve a near-cloaking construction within ρ^N of the ideal cloaking, where ρ is

the regularization parameter and N is the space dimension. This significantly improves the known results in literature, where one could only achieve $|\ln \rho|^{-1}$ in 2D and ρ in 3D. We then develop a special lossy layer which can be taken as a finite realization of the sound-hard lining and called a FSH construction. The FSH construction is shown to posses the same near-cloaking performance as the SH one. Both theoretical and numerical results shall be presented. (Received August 28, 2011)

1075-78-177 **Daniel T Onofrei*** (onofrei@math.uh.edu), University of Houston, Mathematics Department, 4800 Calhoun Road, Houston, TX 77004, and **Andrew Thaler**. *The near-cloak defeats the anti-cloak.*

The subject of shielding or cloaking certain regions of space from electromagnetic or acoustic waves gained a lot of attention in the recent years. One of the most popular ideas for this is to surround the region of interest with a metamaterial layer (high contrast man-made composites) to force the incoming waves to avoid the core region and propagate undisturbed in the far field. In the literature this is referred to as the perfect cloak. In practice tough, one is able only to approximate such a behavior and thus ends up with what is referred to as the near cloak. Recently, the anti-cloak, i.e., a strategy to cancel the effect of perfect cloaking, was proposed. In this talk we will show analytically and numerically, how the near cloak scheme can be adapted to defeat the anti-cloak. (Received August 29, 2011)

1075-78-178 **Daniel Onofrei*** (onofrei@math.uh.edu), University of Houston, Mathematics Department, 4800 Calhoun road, Houston, TX 77004, and **Kui Ren**. *Active manipulation of fields.*

In this talk we will present our recent results regarding the control of electromagnetic fields by using external fixed active sources (antennas). This extremely ill-posed problem has many potential applications, such as, optimal illumination in imaging, shielding and cloaking, remote sensing, illusion optics. We will describe our existing results in the context of the long wavelength limit and finite frequency regime and discuss the current challenges and future ideas. (Received August 29, 2011)

81 ► Quantum theory

1075-81-54 **Louis H Kauffman*** (kauffman@uic.edu), Math UIC, 851 South Morgan Street, Chicago, IL 60607-7045. *Non-Commutative Worlds and Discrete Physics.*

It has long been the case that quantization of a physical system follows the prescription: replace Poisson brackets by commutator brackets. In this way Lie algebra is fundamental to the transition betweem classical and quantum physics. We show how discrete calculus, starting in a commutative domain, can be naturally reformulated as a calculus of commutators in an extended non-commutative domain (so the the derivatives are represented as commuators with special elements of the algebra). In this way there is also a natural passage from discrete calculus to non-commutative domains. We show how this passage illuminates the structure of classical and quantum physics. (Received August 17, 2011)

86 ► Geophysics

1075-86-213 **Kenneth M. Golden*** (golden@math.utah.edu), University of Utah, Department of Mathematics, 155 S 1400 E RM 233, Salt Lake City, UT 84112-0090. *Sea ice and the climate system.*

Sea ice is a porous composite of pure ice with brine inclusions. Fluid flow through sea ice mediates a broad range of processes, such as melt pond evolution and nutrient replenishment for microbial communities. We will discuss recent work in using ideas of composite materials and phase transitions to study sea ice processes which are important in understanding Earth's climate. We'll also discuss the development of electromagnetic methods for monitoring such processes. Our results are helping to improve climate models, and also lend insight into the microstructure of bone, which is similar to that of sea ice. (Received August 30, 2011)

92 ► Biology and other natural sciences

1075-92-118 **Brittany E. Bannish*** (bannish@math.utah.edu), **Aaron L. Fogelson** and **James P. Keener**. *A stochastic multiscale model of fibrinolysis.*

The degradation of blood clots is a tightly regulated process. If the mesh of fibrin fibers securing the clot degrades too slowly, thrombi can form, leading to heart attack or stroke. If the fibrin degrades too quickly, excessive bleeding may occur. We study fibrinolysis (the degradation of fibrin by the main fibrinolytic enzyme, plasmin) using a multiscale mathematical model intended to answer the following question: Why do coarse clots composed of thick fibers lyse more quickly than fine clots composed of thin fibers, despite the fact that individual thin fibers lyse more quickly than individual thick fibers? We use stochastic methods to model lytic processes on scales ranging from individual fiber cross section to whole clot. We find that while fiber number does have an effect on lysis rate, it is not simply "fewer fibers equals faster lysis", as many biologists suggest. We discuss the additional determinants of lysis speed, as well as how patterns and speeds of lysis (both on an individual fiber and clot scale) vary under a range of conditions. This last point is of particular interest for development of treatments for occlusive blood clots. Our model predicts potential targets for future research on effective therapeutic strategies for degrading blood clots. (Received August 25, 2011)

1075-92-165 **Paula Andrea Vasquez*** (pvasquez@unc.edu), Chapel Hill, NC 27514, and **M Gregory Forest**, **Jeremy Cribb** and **Richard Superfine**. *Non-linear signatures of entangled polymer solutions in active microbead rheology.* Preliminary report.

We present an active microrheology protocol, based on magnetically driven microbeads, to measure and interpret nonlinear properties of entangled polymer solutions. The experimental signature is a bead take-off (acceleration) event, signaling a dynamic transition from a linear Stokes to a nonlinear response, while yielding linear and nonlinear properties. Simulations based on the Rolie-Poly model capture the behavior qualitatively, revealing the nonlinear transition as a dynamic strain-thickening event associated with chain entanglement distortions and stress accumulation at the bead surface. (Received August 29, 2011)

1075-92-166 **Joyce T. Lin*** (joyce.lin@utah.edu), University of Utah, Department of Mathematics, 155 S. 1400 E. JWB 233, Salt Lake City, UT 84112, and **James P. Keener**. *A Multiscale Model of Electrical Activity in Cardiac Tissue.* Preliminary report.

The muscular contraction of cardiac tissue that causes blood to pump through the body is driven by electrical stimulation. An accurate, efficient model of action potential propagation is necessary to study arrhythmogensis, as conduction failure has been strongly linked to ventricular arrhythmia and cardiac death.

While gap junctional proteins have traditionally been considered the primary mode of action potential propagation, experimental studies have indicated the existence of another mode. More recent experimental studies have found that cellular geometry plays an important role in propagation velocity. Existing, homogenized models cannot accurately capture the effects of cellular geometry, while more detailed, 3D models are computationally too expensive to be used as predictive tools.

We will present a new, multiscale model that incorporates the complex cellular geometry of cardiac tissue, while remaining numerically efficient. Our 1D and 2D results show field coupling that can only be captured on a microscale domain, yet strongly influences the macroscale behavior of action potential propagation. Additionally, we will explore the effects of the cellular geometry and sodium channel localization on cardiac conduction. (Received August 29, 2011)

1075-92-173 **Jennifer J. Young*** (jjyoung@rice.edu), 6100 Main St. MS#134, Houston, TX 77096, and **Sorin Mitran**. *Multiscale Computation of Cytoskeleton Mechanics.*

Creating accurate, macroscopic scale models of microscopically heterogeneous media is computationally challenging. The difficulty is increased for materials with time-varying micro-structures. This talk will present a new continuum-microscopic (CM) modeling approach aimed at modeling such materials. The cell cytoskeleton, a microscopically fibrous medium was chosen as the material of interest upon which to develop and test the algorithm. What is novel about this algorithm, compared to other CM methods, is that information from the material's micro-structure is saved over time in the form of probability distribution functions (PDFs). These PDFs are then extrapolated forward in time to predict what the micro-structure will look like in the future. Keeping track of the micro-structure over time allows for a more accurate computation of the local mechanical parameters used in the continuum-level equations. Results show that the mechanical parameters computed with this algorithm are similar to those computed with a fully-microscopic model. Errors for continuum level variables in the 5-10% range are deemed an acceptable trade-off for the savings in computational expense offered by this algorithm. (Received August 29, 2011)

1075-92-243 **On Shun Pak*** (s0pak@ucsd.edu), Dept. of Mechanical and Aerospace Engineering, University of California San Diego, 9500 Gilman Drive, La Jolla, CA 92093, and **Saverio Eric Spagnolie**, **Wei Gao**, **Joseph Wang** and **Eric Lauga**. *Biological and bio-inspired locomotion in viscous fluids: from spermatozoa to synthetic microswimmers.*

The locomotion of microorganisms plays a vital role in many important biological processes, such as reproduction and bacterial infection. We will discuss the propulsive mechanism exhibited by many insect spermatozoa which possess a special morphology, which we idealize as a superhelical structure. Resolving hydrodynamic interactions with a non-local slender body theory, we predict the swimming dynamics of these superhelical swimmers based on experimentally collected geometric and kinematic data. Counter-intuitive results are revealed, particularly for the case when the minor and major helical structures are of opposing chirality.

The knowledge obtained by studying natural microorganisms has aided in the development of synthetic micro-swimmers, an avenue which has attracted considerable recent attention due to its promise for biomedical applications such as targeted drug delivery. A new magnetically driven microswimmer which exploits the flexibility of nanowires in order to swim will be presented. Asymptotic analysis of an elasto-hydrodynamic model is found to provide a good prediction of experimental measurements. The number of body lengths traversed per propeller revolution is surprisingly large when compared with that of natural microorganisms and other artificial swimmers. (Received August 30, 2011)

94 ► Information and communication, circuits

1075-94-249 **Lavinia Corina Ciungu*** (lciungu@uco.edu), 100 North University Drive, Edmond, OK 73034, **James Grider** (lciungu@uco.edu), 100 N University Drive, Edmond, OK 73034, and **Matthew Stephens** (lciungu@uco.edu), 100 N University Drive, Edmond, OK 73034. *Building a safe cryptographic code.* Preliminary report.

This papers tries to develop a safe cryptosystem. As the world becomes more connected, the demand for information and electronic services is growing. Protecting data and electronic systems, such as credit card numbers over the Internet, is crucial to our way of living. The techniques to protect data consist of cryptographic codes (i.e. cryptosystems) which encrypt the information needed to be protected. The harder to break, the safer a cryptosystem is, and this is accomplished by using various mathematical techniques. For example, some cryptosystems that are of current use (e.g. RSA) are based on mathematical problems (e.g. decomposition of large integers). The method we would like to explore in this project consists of combining basic cryptosystems to create a more advanced and therefore a stronger code. (Received September 01, 2011)

1075-94-250 **Lavinia Ciungu** (lciungu@uco.edu), 100 North University Drive, EDMOND, OK 73034, and **Cori Bryant*** (lciungu@uco.edu), 100 N University Drive, Edmond, OK 73034. *Password security.* Preliminary report.

Passwords are used in daily life, to prove identity or to allow access to a resource. When loging in to a computer and entering the password, the computer checks the user's identity and then grants access. Storing the passwords can be dangerous, thus the solution is encrypting before storing them. In this paper we will present a few ways of encrypting the passwords, as well as a few attacks on them. We will focus on the birthday attack which is accomplished through the use of hash functions. (Received September 01, 2011)

2010 MATHEMATICS SUBJECT CLASSIFICATION

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