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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
1096	January 15–18, 2014	Baltimore, MD	EXPIRED	Vol 35, No. 1
1097	March 21–23, 2014	Knoxville, TN	January 28	Vol 35, No. 2
1098	March 29–30, 2014	Baltimore, MD	January 28	Vol 35, No. 2
1099	April 5–6, 2014	Albuquerque, NM	February 11	Vol 35, No. 2
1100	April 11–13, 2014	Lubbock, TX	February 10	Vol 35, No. 2
1101	June 16–19, 2014	Tel Aviv, Israel	TBA	NA
1102	September 20–21, 2014	Eau Claire, WI	July 29	Vol 35, No. 3
1103	October 18–19, 2014	Halifax, Canada	August 19	Vol 35, No. 3
1104	October 25–26, 2014	San Francisco, CA	September 3	Vol 35, No. 4
1105	November 8–9, 2014	Greensboro, NC	September 16	Vol 35, No. 4
1106	January 10–13, 2015	San Antonio, TX	TBA	Vol 36, No. 1

ST. LOUIS, MO, October 18–20, 2013

Abstracts of the 1094th Meeting.

00 ► General

1094-00-19 **Stewart Ernest Brekke*** (stewabruk@aol.com), 2900 Maple ave, Downers Grove, IL 60515. *Oscillating Parallelisms, Convergences and Divergences of Two Dimensions.*

Convergent lines come towards a point, divergent lines go away from a point and parallel lines are equidistant. Oscillating curves may have their amplitudes of ocillation remain the same, diminish or increase over increasing distance. If lines are made in each case connecting the maximum amplitudes of oscillation, those lines may be parallel,convergent or divergent in each type of oscillation. The amount of convergence and divergence in each type of line pair can be quantified by the angle of convergence or divergence. The quantification of parallelism is quantified by the inverse of the distance between the parallel lines. An example of convergent and divergent oscillators is $u = tsint$. This oscillator is convergent as $-t$ approaches 0 and is divergent as t increases from 0 to greater t. $y = sinx$ is an example of a parallel oscillator with the positive and negative amplitudes always equidistant. (Received July 08, 2013)

1094-00-35 **Jonas Aziz Azzam*** (jonasazzam@math.washington.edu). *Quantitative differentiation of quasisymmetric maps in Euclidean space.*

For $f : \mathbb{R}^d \to \mathbb{R}^D$ quasisymmetric, we introduce a quantity $w_f(x, r)$ that (1) measures how close f is to being an affine map in the ball $B(x, r) \subseteq \mathbb{R}^d$ and (2) is invariant under translations and dilations in the domain of f as well as under rescalings of f in its image. We show that f has large bi-Lipschitz pieces of $\mathbb{R}^d$ in its image (though the image may not be $\mathcal{H}^d$-finite) if and only if $w_f(x, r)^2 \frac{dx\,dr}{r}$ is a Carleson measure on $\mathbb{R}^d \times (0, \infty)$. Some cornerstones of the proof include David-Semmes theory, Dorronsoro's characterization of Sobolev spaces, and Semmes' work on strong A_∞-weights. (Received July 23, 2013)

1094-00-77 **Necibe Tuncer**, necibe-tuncer@utulsa.edu, and **Trang Le***, trang-le@utulsa.edu. *Spread of Avian Influenza Pandemic to U.S.A. via Air Travel.*

We introduce a two-patch mathematical model to forecast the global spread of pandemic avian influenza by supposing that the pandemic starts in Asia and spreads to USA by air travel, considering a total of 12 major airports in both regions. We derive the reproduction number of the two-patch model and compute the sensitivity of the parameters such as transmission and death rate of pandemic avian influenza. (Received August 11, 2013)

03 ► Mathematical logic and foundations

1094-03-36 **Timothy H. McNicholl***, Department of Mathematics, Iowa State University, Ames, IA 50011. *Computable and Incomputable Boundary Extensions of Conformal Maps.*

Suppose ϕ is a conformal map on the unit disk (that is, the open disk whose center is the origin and whose radius is 1) onto a domain D. If ϕ has a continuous extension to the closed unit disk, then this extension is referred to as the *boundary extension* of ϕ. A well-known theorem states that the boundary extension of ϕ exists if and only if the boundary of D is bounded and locally connected. In addition, if the boundary of D is a Jordan curve, then the boundary extension of ϕ is a homeomorphism. We show that one direction of this theorem holds effectively in that if ϕ is computable and if the boundary of D is effectively locally connected, then the boundary extension of ϕ is computable. However, we show that the other direction fails effectively in that there is a computable conformal map that has a boundary extension even though the boundary of its range is not effectively locally connected. Furthermore, we show that there is a computable conformal map from the unit disk onto a Jordan domain whose boundary extension is incomputable. Altogether, these results say that effective local connectivity provides sufficient, non-superfluous, but excessive information for the computation of boundary extensions. (Received July 23, 2013)

1094-03-76 **Chris J Conidis***, chris.conidis@vanderbilt.edu. *The Computable Structure of Artinian Rings.*

We will present some recent results regarding the definability and computability structure of computable Artinian rings, as well as some reverse mathematical consequences. (Received August 11, 2013)

1094-03-187 **Kelty Allen*** (kelty@math.berkeley.edu) and **Laurent Bienvenu**. *Martin-Lof random Brownian motion.* Preliminary report.

We define Martin-Löf random Brownian motion and investigate some of its properties. We will cover some of the "almost surely" results from classical probability theory that hold for MLR Brownian motion, and discuss some of the many interesting results about the zero set of a sample path. (Received August 22, 2013)

1094-03-189 **Jonathan Stephenson*** (jrs@math.uchicago.edu). *Isomorphisms between low_n and computable boolean algebras.*

A long-standing problem in the area of computable structures is to determine for which n every low_n boolean algebra is isomorphic to a computable boolean algebra. For those n where such isomorphisms exist, a related problem is that of determining how complicated the isomorphisms between low_n boolean algebras and computable algebras must be.

Harris and Montalbán have demonstrated the existence of a low_5 boolean algebra that is not isomorphic to any computable boolean algebra via a $\emptyset^{(7)}$-computable map. Using Montalbán's machinery for diagonalizable structures, we can show that proofs in the style of Harris and Montalbán's exist for low_{n+2} boolean algebras whenever they exist for low_n boolean algebras. (Received August 23, 2013)

1094-03-201 **Victor A Ocasio*** (vocasiog@nd.edu), Department of Mathematics, 255 Hurley Building, University of Notre Dame, Notre Dame, IN 46617. *Transferring relative categoricity from linear orders to algebraic structures.*

In 1974, Nurtazin characterized all computably categorical decidable structures in a complete theory. It implies, that in the class of Real Closed Fields (RCF), only those structures with finite transcendence degree are computably categorical. In 2004, Calvert showed that an archimedean real closed field is Δ^0_2 categorical. Melnikov [2010], showed that categoricity results can be transferred from linear orders to abelian groups. Using some of his techniques, we are able to transfer the results from linear orders to real closed fields and explore how it may lead to a more general result. (Received August 23, 2013)

1094-03-223 **Kyle Riggs*** (kwriggs@umail.iu.edu). *The Σ^1_1-Completeness of the Decomposability Problem for Torsion-Free Abelian Groups.*

An abelian group is decomposable if it can be written as the direct sum of two (or more) nontrivial subgroups. Among torsion groups, the decomposable groups have previously been completely characterized. Among torsion-free groups, we show that this property is Σ^1_1-complete, so it cannot be characterized by a first-order formula in the language of arithmetic. (Received August 24, 2013)

1094-03-260 **Barbara F Csima***, Department of Pure Mathematics, University of Waterloo, Waterloo, Ontario N2L 3G1, Canada. *Isomorphisms of Structures.* Preliminary report.

What can be coded into isomorphisms of a computable structure? We discuss the related notions of degrees of categoricity, low for isomorphism and low for categoricity. (Received August 26, 2013)

1094-03-261 **Karen Lange** (klange2@wellesley.edu), **Russell Miller*** (russell.miller@qc.cuny.edu) and **Rebecca Steiner** (rebecca.m.steiner@vanderbilt.edu). *Effective classification of computable structures.*

The paradigm of a *computable classification* is the Friedberg enumeration. Friedberg produced a uniformly computable listing of all computably enumerable sets, with no set appearing more than once in the listing. That is, he gave a computable classification of the c.e. sets up to set equality. We apply his method to yield a computable classification, up to (classical) isomorphism, of the computable algebraic fields: a uniformly computable presentation listing all such fields, with no isomorphism between any two of them. We also follow Goncharov and Knight in showing that certain other classes have no computable classification.

Finally, we give a $\mathbf{0'}$-computable classification of the computable equivalence structures. This result, which extends more work of Goncharov and Knight, means that there is a uniformly $\mathbf{0'}$-computable listing of all computably presentable equivalence structures, with no isomorphism between any two structures on the list; however, the structures on the list are only $\mathbf{0'}$-computable, not necessarily computable. We conjecture that there is no computable classification of the computable equivalence structures. (Received August 26, 2013)

1094-03-307 **Julia F. Knight*** (knight.1@nd.edu) and **Charles McCoy**. *Index sets and Scott sentences.* Preliminary report.

For a computable structure $\mathcal{A}$, there may not be a computable infinitary Scott sentence. When there is a computable infinitary Scott sentence φ, then the complexity of the index set $I(\mathcal{A})$ is bounded by that of φ. Several results on optimal Scott sentences for Abelian p-groups, free groups, and other structures have been arrived at because of the authors' belief that the complexity of the index set should match that of an optimal Scott sentence. In this note, we show that there is not always a perfect match. We show that for a certain subgroup of $\mathbb{Q}$, there is no computable d-Σ_2 Scott sentence, even though the index set is d-Σ^0_2. (Received August 26, 2013)

1094-03-319 **Valentina Harizanov*** (harizanv@gwu.edu), Department of Mathematics, The George Washington University, Washington, DC 20052. *Sigma-0-1 and Pi-0-1 structures.*

Σ^0_1 and Π^0_1 structures have been studied since the beginning of modern computable model theory. Here, we focus on equivalence and injection structures. There are Σ^0_1 and Π^0_1 equivalence structures that are not isomorphic to computable ones. If Σ^0_1 equivalence structures $\mathcal{A}$ and $\mathcal{B}$ are isomorphic to a computable structure that is relatively Δ^0_2-categorical, then $\mathcal{A}$ and $\mathcal{B}$ are Δ^0_2-isomorphic. On the other hand, for every computable Δ^0_2-categorical equivalence structure that is not computably categorical, there is an isomorphic Π^0_1 equivalence structure that is not Δ^0_2-isomorphic to any computable structure. While every Σ^0_1 injection structure is computably isomorphic to a computable structure, there are Π^0_1 injection structures that are not isomorphic to computable ones. In contrast to Π^0_1 equivalence structures, the results on the complexity of isomorphisms for Π^0_1 injection structures that are isomorphic to Δ^0_2-categorical structures are mixed.

This is joint work with D. Cenzer and J. Remmel. (Received August 26, 2013)

1094-03-330 **Jan Reimann*** (reimann@math.psu.edu), Department of Mathematics, McAllister Bldg, Pennsylvania State University, University Park, PA 16802. *Effective multifractal spectra.*

We study effective aspects of multifractal spectra. We show that the spectrum of pointwise effective dimensions reflects many important properties in both the dynamical and the probabilistic setting. We prove a consistency property for correlation dimension that allows us to apply effective/constructive dimension to point processes such as earthquakes. (Received August 27, 2013)

1094-03-365 **Linda Brown Westrick*** (westrick@math.berkeley.edu). *A lightface analysis of the differentiability rank.*

We examine the computable part of the differentiability hierarchy defined by Kechris and Woodin. In that hierarchy, the rank of a differentiable function is an ordinal less than ω_1 which measures how complex it is to verify differentiability for that function. We show that for each recursive ordinal $\alpha > 0$, the set of Turing indices of $C[0,1]$ functions that are differentiable with rank at most α is $\Pi_{2\alpha+1}$-complete. This result is expressed in the notation of Ash and Knight. We also discuss connections with related hierarchies. (Received August 27, 2013)

1094-03-372 **Rebecca M. Steiner*** (rebecca.m.steiner@vanderbilt.edu), Department of Mathematics, Vanderbilt University, 1326 Stevenson Center, Nashville, TN 37203. *Effective Symmetry Breaking.*

Symmetry breaking in combinatorics involves coloring the elements of a structure so that there are no nontrivial automorphisms of the structure which respect the coloring. We say that such a coloring *distinguishes* the structure.

We apply computability theory to this notion and show that there is a computable, finite-valence, pointed graph which is distinguished by a 2-coloring but not by any computable 2-coloring.

We also show that if a computable, finite-branching tree has a distinguishing 2-coloring, then it must have a $\mathbf{0}'$-computable distinguishing 2-coloring. We don't know yet if the same is true in the more general case of computable, finite-valence, pointed graphs. (Received August 27, 2013)

1094-03-399 **Jason M Rute*** (jmr71@math.psu.edu). *Schnorr randomness and computable analysis.*

In the computable analysis of measure theory, probability theory, dynamical systems, stochastic calculus, and calculus of variations it is helpful to replace "almost everywhere" theorems with theorems that refer to a specific measure-one set of "random" points. Traditionally, Martin-Löf randomness has been used for this purpose with great success.

However, recently it has become apparent that Martin-Löf randomness is not always the correct randomness notion. Instead, Schnorr randomness, a more effective cousin of Martin-Löf randomness, is better suited for many tasks. I will make this clear and formal by surveying a number of effective almost-everywhere convergence theorem which characterize Schnorr randomness. These include differentiability and martingale convergence theorems as well as others.

I will also talk about applications of computable analysis to the study of Schnorr randomness. (Received August 28, 2013)

1094-03-409 **Mojtaba Moniri*** (m-moniri@wiu.edu). *Nathanson sequence for real parameters with irrational log, and successive differences.* Preliminary report.

Among one-to-one correspondences between real numbers and sequences of natural numbers, and of the many ways a sequence of natural numbers could depend on a real parameter, we consider a recent one by Melvyn Nathanson in his May 2013 issue of the American Mathematical Monthly. From calculus, one remembers that the roots, when the index goes to infinity, of a positive real number tend to 1. To isolate a real number grater than 1 (and specially also less than e and with irrational natural log) more and more, it is interesting to find the integer parts of the reciprocals of the errors corresponding to more and more root indices. E.g., the real number 2 would correspond to the sequence $1, 2, 3, 5, 6, 8, 9, 11, 12, 13, 15, 16, 18, 19, 21, 22, 24, 25, 26, 28, 29, 31, 32, 34, 35, 37, 38, 39, 41, 42, \cdots$. Nathanson asked how "almost periodic" the sequence of successive differences of the sequence above is. We study this computable sequence $(\lfloor \frac{1}{2^{\frac{1}{n+1}}-1} \rfloor - \lfloor \frac{1}{2^{\frac{1}{n}}-1} \rfloor)_{n\in\mathbb{N}\geq 1}$. Joint work with Iraj Kalantari. (Received August 29, 2013)

05 ► Combinatorics

1094-05-31 **Kyle Petersen*** (tpeter21@depaul.edu), Department of Mathematical Sciences, Chicago, IL 60614. *Combinatorics of the shard intersection order of a Coxeter group.*

Nathan Reading introduced the shard intersection order in 2011. This is a poset on the regions in a simplicial hyperplane arrangement, which, in the case of a Coxeter arrangement, contains the lattice of noncrossing partitions as a full-rank sublattice. Moreover, its rank generating function is the W-Eulerian polynomial.

I will discuss combinatorial models for the poset in types A, B, and D, and exhibit EL-labelings. The question of EL-shellability in general is still open. Further, I will discuss the idea of a *symmetric boolean decomposition* of the shard intersection orders, which is proved in type A and conjectured for all types. (Received July 19, 2013)

1094-05-91 **Bridget Tenner*** (bridget@math.depaul.edu). *A poset, a graph, and some derangements.*

In the Bruhat order of a Coxeter system, the collection of elements with boolean principal order ideals describes a simplicial complex. The homotopy type of this complex is a wedge of spheres, and the number of spheres can be computed recursively, using discrete Morse theory, from the underlying graph of the system. The homology of the complex can be expressed in terms of derangements of the graph's vertices. This is joint work with Ragnarsson. (Received August 13, 2013)

1094-05-107 **Benjamin Braun*** (benjamin.braun@uky.edu), 715 Patterson Office Tower, University of Kentucky, Lexington, KY 40514, and **Sarah Crown Rundell** (rundells@denison.edu), Department of Math and Computer Science, Denison University, 100 West College St, Granville, OH 43023. *Hyperoctahedral Eulerian Idempotents, Hodge Decompositions, and Signed Graph Coloring Complexes.* Preliminary report.

Phil Hanlon proved that the coefficients of the chromatic polynomial of a graph G are equal (up to sign) to the dimensions of the summands in a Hodge-type decomposition of the top homology of the coloring complex for G. We prove a type B analogue of this result for chromatic polynomials of signed graphs using hyperoctahedral Eulerian idempotents. (Received August 15, 2013)

1094-05-126 **Elizabeth Drellich*** (drellich@math.umass.edu). *Peterson Varieties: A Uniform Giambelli's Formula.*

Peterson Varieties are subvarieties of the flag variety. While they are not GKM spaces, there is a one-dimensional torus action on them with nice combinatorial properties. Under this action we can construct a basis of the equivariant cohomology ring of the Peterson variety, and compute in that ring. This talk will give a Giambelli's formula that is uniform across Lie type. (Received August 17, 2013)

1094-05-169 **Benjamin J. Wyser**, UIUC Math Dept 1409 W. Green Street, Urbana, IL 61801, and **Alexander Yong*** (ayong@uiuc.edu), UIUC Math Dept., 1409 W. Green Street, Urbana, IL 61801. *Polynomials for $GL_p \times GL_q$ orbit closures in the flag variety.*

The subgroup $K = GL_p \times GL_q$ of GL_{p+q} acts on the flag variety GL_{p+q}/B with finitely many orbits. We introduce a family of polynomials that specializes to representatives for cohomology classes of the orbit closures in the Borel model. We define and study K-orbit determinantal ideals to support the geometric naturality of these representatives. Using a modification of these ideals, we describe an analogy between two local singularity measures: the H-polynomials and the Kazhdan-Lusztig-Vogan polynomials. (Received August 21, 2013)

1094-05-210 **James Davis**, **Patricia Hersh*** (plhersh@ncsu.edu) and **Ezra Miller**. *Fibers in total positivity.* Preliminary report.

I will discuss efforts to understand the inverse image of a point under a fundamental map from Lie theory. It is conjectured that this is a regular CW complex homeomorphic to a ball. Subword complexes and the nerve lemma play a role in this story. (Received August 23, 2013)

1094-05-221 **Jonathan Browder** and **Steven Klee***, Seattle University Department of Mathematics, 901 12th Avenue, Seattle, WA 98122. *A classification of the face numbers of Buchsbaum simplicial posets.*

The family of Buchsbaum simplicial posets over a field **k** provides an algebraic abstraction of the family of (**k**-homology) manifold triangulations. In 2008, Novik and Swartz established lower bounds on the face numbers of a Buchsbaum simplicial poset as a function of its dimension and the dimension of its **k**-homology spaces; and they conjectured that these lower bounds are sufficient to classify face numbers of Buchsbaum simplicial posets with prescribed Betti numbers. We prove this conjecture by using methods from the theory of (pseudo)manifold crystallizations to construct simplicial posets with prescribed face numbers and Betti numbers. (Received August 24, 2013)

1094-05-275 **Nicholas Teff*** (teffnico@grinnell.edu), Department of Mathematics and Statistics, Grinnell College, Grinnell, IA 50112-1690. *Divided difference operators for regular semisimple Hessenberg varieties.*

The cohomolgy ring of a regular semisimple Hessenberg varieties affords a representation of the symmetric group that generalizes the Springer representation and has found recent applications in the long-standing (3+1)-conjecture for the chromatic symmetric function. Divided difference operators are recursive maps that construct the cohomology basis of Schubert classes for the complete flag variety.

In this talk, I discuss the existence of divided difference operators that construct a cohomology basis for a regular semisimple Hessenberg variety. This construction uses a combinatorial construction of (equivariant) cohomology called GKM theory. This construction allows us to use the combinatorics of the Bruhat order of the symmetric group to define the divided difference operator. (Received August 26, 2013)

1094-05-276 **Richard Ehrenborg*** (jrge@ms.uky.edu), Department of Mathematics, University of Kentucky, Lexington, KY 40506, and **Margaret A. Readdy** (readdy@ms.uky.edu), Department of Mathematics, University of Kentucky, Lexington, KY 40506. *Manifold arrangements.*

Ehrenborg, Goresky and Readdy have developed a new theory of Euler flag enumeration of Whitney stratified spaces, and more generally, quasi-graded posets. This setting enables them to extend the classical notion of Eulerianness, and show the cd-index, a noncommutative polynomial which has been key to understanding the flag vector of polytopes, exists for Whitney-stratified spaces. Unlike Stanley's nonnegativity result for spherically-shellable posets, the coefficients of the cd-index for Whitney-stratified spaces can be negative. We focus on the induced subdivision arising from a manifold arrangement. This generalizes earlier results in several directions: (i) One can work with manifolds other than the n-sphere and n-torus, (ii) the induced subdivision is a Whitney stratification, and (iii) the submanifolds in the arrangement are no longer required to be codimension one. (Received August 26, 2013)

1094-05-289 **Ghodratollah Aalipour** (alipour.ghodratollah@gmail.com) and **Art Duval*** (artduval@math.utep.edu). *Weighted spanning enumerators of color-shifted simplicial complexes.*

A color-shifted complex on r colors is an $(r-1)$-dimensional simplicial complex whose vertices are partitioned into r disjoint color classes, with a linear order on the vertices in each color class, and whose facets satisfy the following conditions: (a) Every facet contains exactly one vertex of each color; and (b) If $v < w$ are two vertices of the same color, then if F is a facet in the complex, and $w \in F$, then $F\backslash\{w\}\cup\{v\}$ is also a facet in the complex. Ehrenborg and van Willigenburg counted weighted spanning trees of Ferrers graphs, which may be described as color-shifted complexes with $r = 2$. We find a factorization of a weighted enumeration of top-dimensional spanning trees of color-shifted complexes on $r = 3$ colors, and we conjecture our technique will extend to all r. The proof relies on the simplicial Matrix-Tree Theorem, and identification of factors, as in Martin and Reiner. (Received August 26, 2013)

1094-05-368 **Art M Duval**, **Caroline J Klivans** and **Jeremy L Martin*** (jmartin@math.ku.edu). *The cocritical group of a cell complex.*

The cocritical group of a cell complex X is defined dually to its critical group. Like the critical group, the cocritical group can be interpreted as a torsion-weighted enumerator of cellular spanning trees, but by cohomology instead of homology. Roughly speaking, torsion in a cell complex tends to complicate its critical group while simplifying its cocritical group. When X is torsion-free (for example, when it is a graph), the two groups are naturally isomorphic; however, in some cases, such as cellular manifolds, the cocritical group is considerably easier to calculate than the critical group. (Received August 27, 2013)

1094-05-385 **Rafael S. González D'León*** (dleon@math.miami.edu). *On the free Lie algebra with k compatible brackets and poset topology.* Preliminary report.

It is a classical result that the multilinear component of the free Lie algebra with n generators $\mathcal{L}ie(n)$ has dimension $(n-1)!$. It is also well known that $\mathcal{L}ie(n)$ is isomorphic as an $\mathfrak{S}_n$-module to the top cohomology of the poset of set partitions Π_n tensored with the sign representation. A conjecture of Feigin proved independently by Dotsenko-Khoroshkin and Liu is that the dimension of the multilinear component of the free Lie algebra with two compatible brackets $\mathcal{L}ie_2(n)$ is n^{n-1}. We study the free Lie algebra with k compatible brackets $\mathcal{L}ie_k(n)$ and extend results on the dimensions of $\mathcal{L}ie(n)$ and $\mathcal{L}ie_2(n)$ thereby answering some questions of Liu. Our technique is to construct an explict isomorphism between $\mathcal{L}ie_k(n)$ and the top cohomology of a poset of weighted partitions and then to apply tools from poset topology. This extends previous work of González D'León and Wachs on the $k = 2$ case. (Received August 27, 2013)

1094-05-391 **John Shareshian** and **Michelle L Wachs*** (wachs@math.miami.edu). *A geometric interpretation of an Eulerian number identity.* Preliminary report.

Chung, Graham and Knuth obtained the following identity involving Eulerian numbers and binomial coefficients

$$\sum_{m=1}^{n} \binom{n}{m} a_{m,j-1} = \sum_{m=1}^{n} \binom{n}{m} a_{m,n-j-1}.$$

In this talk we give geometric interpretations of this identity, of a q-analog due to Chung-Graham and Han-Lin-Zeng, and of a symmetric function generalization due to Shareshian-Wachs. Our interpretation involves the h-vector of the stellohedron and the representation of the symmetric group on the cohomology of the associated toric variety. (Received August 27, 2013)

11 ► Number theory

1094-11-79 **Baiying Liu*** (liuxx969@umn.edu), Department of Mathematics, University of Utah, 155 S 1400 E Room 233, Salt Lake City, UT 84112. *Arthur Parameters and Fourier coefficients for Automorphic Forms on Symplectic Groups.*

We study the structures of Fourier coefficients of automorphic forms on symplectic groups based on their local and global structures related to Arthur parameters. This is a first step towards the general conjecture on the relation between the structure of Fourier coefficients and Arthur parameters given by Jiang in 2012.

This is a joint work with Prof. Dihua Jiang. (Received August 11, 2013)

1094-11-88 **Ralf Schmidt*** (rschmidt@math.ou.edu). *Some results on Bessel functionals for GSp(4).*

As is well known, Whittaker functionals for irreducible, admissible representations of a reductive algebraic group over a local field play a very important role in automorphic representation theory. In cases where Whittaker functionals are not available, Bessel functionals can sometimes play a similar role. Bessel functionals tend to exist more often than Whittaker functionals. For example, for the group GSp(4) over a non-archimedean local field F, every representation admits some Bessel functional, while only about "half" of all representations admit a Whittaker functional.

It turns out that for GSp(4) one can make a complete list of ALL possible Bessel functionals for all non-supercuspidal representations. One can also make a complete list of all SPLIT Bessel functionals for ALL representations. We present these results and explain how they can be obtained.

Several facts about existence and uniqueness of Bessel functionals for GSp(4) are widely assumed to be true, but in fact poorly documented in the literature. The methods used to obtain the lists of all Bessel functionals can also be used to prove their existence in general, and uniqueness in many cases.

This is joint work with Brooks Roberts. (Received August 12, 2013)

1094-11-89 **Jeff Breeding*** (jbreeding@fordham.edu), 441 East Fordham Road, Fordham University, Department of Mathematics, Bronx, NY 10458. *Dimension formulas via the Jacquet functor.*

Consider the connected reductive algebraic group $G = \mathrm{GSp}(4, F)$ defined over a non-archimedean local field F of characteristic zero with ring of integers $\mathfrak{o}$ and maximal ideal $\mathfrak{p}$. Let (π, V) be an admissible representation of G. In this talk, we discuss how to use the Jacquet functor and the work of Moy and Prasad to compute the dimensions of spaces of $\Gamma(\mathfrak{p})$-fixed vectors of π, where $\Gamma(\mathfrak{p})$ is the principal congruence subgroup of G of level $\mathfrak{p}$. (Received August 13, 2013)

1094-11-148 **Radhika Ganapathy*** (rganapat@math.ubc.ca). *The Deligne-Kazhdan theory and its applications the local Langlands correspondence.*

The Deligne-Kazhdan theory can be loosely described as follows:

"The (complex) representation theory of Galois groups and split reductive groups over a local field of characteristic p can be viewed as the limit, as the ramification index tends to infinity, of the representation theory of these groups over local fields of characteristic 0 with the same residue field."

In this talk, we will first briefly review this theory. We will then briefly explain how this theory can be used to prove the local Langlands correspondence for $GSp_4(F)$ for a local function field F of characteristic > 2. (Received August 20, 2013)

1094-11-154 **Yeansu Kim*** (kim407@math.purdue.edu), 14 MacLean Hall, Department of Mathematics, University of Iowa, Iowa City, IA 52242-1419. *Strongly positive representations of GSpin groups and its applications.*

The classification of discrete series representations of connected reductive groups G over non-archimedean local field F of characteristic zero is one of the important steps in local Langlands correspondence. In this talk, I will explain the classification of so-called strongly positive discrete series representations in the case of *GSpin* groups over F and describe the general discrete series representations of *GSpin* groups over F using the classification of strongly positive representations. I will also explain Tadic's structure formula in the case of *GSpin* groups which is one of the main tools. One of the applications of this classification results is to show the equality of L-functions from Langlands-Shahidi method and Artin L-functions through local Langlands correspondence. (Received August 21, 2013)

1094-11-170 **Bryan F Clair*** (bryan@slu.edu). *The Riemann surface of a function arising from combinatorial problems on the infinite grid.*

The zeta function of a graph is the generating function for closed loops in the graph. Computing the zeta function for the infinite grid leads to a multivalued complex function given by an integral over the torus. This same integral appears in the classical Ising model of a magnet, where only real values of the parameter are of physical interest. In this talk, I will survey these two combinatorial problems, and then apply Elliptic integrals to describe the Riemann surface associated to the function. (Received August 21, 2013)

1094-11-202 **Li-Mei Lim*** (llim@math.brown.edu). *Counting Square Discriminants.*

Hee Oh and Nimish Shah prove that the number of integral binary quadratic forms whose coefficients are bounded by a quantity X, and with discriminant a fixed square integer d, is $cX \log X + O(X(\log X)^{\frac{3}{4}})$. This result was obtained by the use of ergodic methods. I will describe a result using the method of shifted convolution sums of Fourier coefficients of certain automorphic forms to obtain a sharpened result of a related asymptotic, obtaining a second main term and an error of $O(X^{\frac{1}{2}})$. This is joint work with Thomas Hulse, E. Mehmet Kiral, and Chan Ieong Kuan. (Received August 23, 2013)

1094-11-227 **Samuel Hardwick***, Mathematics Department, 202 Mathematical Sciences Bldg, University of Missouri, Columbia, MO 65211. *Collatz Problem.*

The Collatz conjecture states that any sequence of natural numbers $\{a_n\}_{n=1}^{\infty}$ defined recursively by $a_{n+1} := 3a_n + 1$ if a_n is odd and $a_{n+1} := a_n/2$ if a_n is even, will eventually become the repeating sequence $4, 2, 1$. We prove that if such a sequence is bounded, then it will eventually become the repeating sequence $4, 2, 1$. (Received August 25, 2013)

1094-11-236 **Ameya Pitale*** (apitale@ou.edu). *Central L-values and test vectors.*

I will be talking about the central value of the L-function attached to the twist of the base change of a cuspidal automorphic representation of GL(2) by a character. We will generalize the original work of Waldspurger which gives a formula in terms of a certain period integral. We will follow the method of Jacquet and Chen using relative trace formula to obtain an explicit formula. This requires precise knowledge of local test vectors for Waldspurger functionals and I will present recent progress towards that. This leads to several interesting applications such as explicit average formula, non-vanishing of central L-value and non-vanishing mod p. This is joint work with Daniel File and Kimball Martin. (Received August 25, 2013)

1094-11-240 **Dominic Lanphier*** (dominic.lanphier@wku.edu), Department of Mathematics, 1906 College Heights Blvd #11078, Bowling Green, KY 42101. *Non-vanishing of Rankin-Selberg L-functions.*

It was shown by Kohnen that, in a certain sense, the Generalized Riemann Hypothesis holds on average for L-functions attached to level 1 holomorphic cuspforms. This result was later generalized by Raghuram to L-functions attached to certain cuspidal automorphic representations. A similar result was shown for symmetric-square L-functions by Li and, using different methods, by Kohnen and Sengupta. By studying certain kernels attached to two cuspidal automorphic representations, we obtain similar results for Rankin-Selberg convolution L-functions. We also investigate consequences of these results. (Received August 25, 2013)

1094-11-248 **Ramin Takloo-Bighash*** (rtakloo@math.uic.edu), Dept of Math, Stat, and Comp Sci, University of Illinois at Chicago, 851 S Morgan St (M/C249), Chicago, IL 60607. *On certain Siegel modular forms.* Preliminary report.

In this talk I will describe a work in progress with Kumar Murty in which we characterize certain Siegel modular forms which arise in connection with Abelian surfaces. (Received August 25, 2013)

1094-11-296 **Min Lee*** (minlee@math.brown.edu), 151 Thayer St, Providence, RI 02912, and **Jeffrey Hoffstein**. *Second Moments and Simultaneous non-vanishing of GL(2) automorphic L-series.*

We obtain a second moment formula for the L-series of holomorphic cusp forms, averaged over twists by Dirichlet characters modulo a fixed conductor Q. The estimate obtained has no restrictions on Q, with an error term that has a close to optimal power savings in the exponent. However, one of the contributions to the main term is a special value of a shifted double Dirichlet series. We show that this special value is small on average, and obtain a corresponding estimate for a mean value of the second moment over Q. This mean value is non- zero even when applied to a product of two distinct L-series, leading to a simultaneous non-vanishing result. Our approach uses the theory of shifted multiple Dirichlet series to obtain some refined estimates for dou- ble shifted sums. These estimates are the key ingredient in the second moment estimate. (Received August 26, 2013)

1094-11-350 **Mohammad K. Azarian*** (azarian@evansville.edu), Mathematics Department, University of Evansville, 1800 Lincoln Avenue, Evansville, IN 47722. *Euler's Number Via Difference Equations.*

In this presentation we use two second-order linear homogeneous difference equations with variable coefficients as well as one second-order linear homogeneous difference equation with constant coefficients to obtain Euler's number. Also, we obtain Euler's number by using two first-order linear difference equations with variable coefficients, one homogeneous and one nonhomogeneous. We conclude the presentation by posing some questions. (Received August 27, 2013)

13 ► Commutative rings and algebras

1094-13-29 **Sankar P Dutta*** (dutta@math.uiuc.edu), 1403 W. Green Street, Urbana, IL 61801. *On Modules of Finite Projective Dimension.* Preliminary report.

We address two aspects of finitely generated modules of finite projective dimension over local rings and their connection in between: embeddability and grade of order ideals of minimal generators of syzygies. We provide a solution of the embeddability problem and prove important reductions and special cases of the order ideal conjecture. In particular we derive that in any local ring R of mixed characteristic p > 0, where p is a non-zero-divisor, if I is an ideal of finite projective dimension over R and p is in I or p is a non-zero-divisor on R/I, then every minimal generator of I is a non-zero-divisor. Hence if P is a prime ideal of finite projective dimension in a local ring R, then every minimal generator of P is a non-zero-divisor in R. (Received July 16, 2013)

1094-13-34 **Sema Gunturkun*** (gunturkun@ms.uky.edu) and **Uwe Nagel**. *Constructing Homogeneous Gorenstein Ideals.* Preliminary report.

A way of constructing Gorenstein ideals from small Gorenstein ideals in local Gorenstein rings is shown by A. Kustin and M. Miller in 1983. In this talk, we show a variant of their construction for graded case and avoid the ring extension. We see that how the liaison theory helps us immensely to modify their construction. (Received August 28, 2013)

1094-13-53 **Nicholas R Baeth*** (baeth@ucmo.edu), W. C. Morris 213, University of Central Missouri, Warrensburg, MO 64093, and **Alfred Geroldinger** (alfred.geroldinger@uni-graz.at), Room 526, Heinrichstrasse 36, Karl Franzens University, 8010 Graz, Austria. *Arithmetic of direct-sum decompositions of modules.*

If $(R, \mathfrak{m})$ is a commutative Noetherian local ring, then the monoid $V(R)$ consisting of isomorphism classes of finitely generated R-modules with operation given by $[M] + [N] = [M \oplus N]$ is a Krull monoid. All information about direct-sum decompositions of finitely generated R-modules is encoded in the arithmetic of this monoid. Moreover, if $\widehat{R}$ is the $\mathfrak{m}$-adic completion of R, then $V(\widehat{R})$ is free with basis $\mathcal{P}$ of isomorphism classes of indecomposable finitely gnerated $\widehat{R}$-modules, the natural map ϕ from $V(R)$ to $V(\widehat{R})$ maping $[M]$ to $[\widehat{M}]$ is a divisor homomorphism, and the isomorphism class of $V(R)$ is completely determined by the class group $\mathcal{C}(\phi)$ of ϕ and the sets $\phi(\mathcal{P})$ and $\phi^{-1}(\phi(\mathcal{P}))$. We illustrate how this information can be used to measure subtle variations in terms of unique and non-unique direct-sum decompositions of finitely generated R-modules. (Received August 02, 2013)

1094-13-57 **Craig Huneke**, **Srikanth Iyengar** and **Roger Wiegand*** (rwiegand@math.unl.edu). *Rigid modules over complete intersections.* Preliminary report.

Let $(R, \mathfrak{m})$ be a local complete intersection domain. A finitely generated R-module is said to be *rigid* provided $\operatorname{Ext}^1_R(M, M) = 0$. We study the question of existence of non-free rigid modules. When R is one-dimensional and M is torsion-free, $\operatorname{Ext}^1_R(M, M)$ is the Matlis dual of the torsion submodule of $M \otimes_R M^*$, where M^* is the dual module $\operatorname{Hom}_R(M, R)$. Our study is thus related to the conjecture, in dimension one, that $I \otimes_R I^*$ must have torsion if I is a non-principal ideal. (Received August 05, 2013)

1094-13-63 **William Heinzer** (heinzer@math.purdue.edu), **Christel Rotthaus** (rotthaus@math.msu.edu) and **Sylvia Wiegand*** (swiegand1@math.unl.edu), Dept. of Mathematics, Univ. of Nebraska, Lincoln, NE 68588-0130. *Formal fibers of prime ideals in polynomial rings.* Preliminary report.

Let $(R, \mathbf{m})$ be a Noetherian local domain of dimension n that is essentially finitely generated over a field and let $\widehat{R}$ be the $\mathbf{m}$-adic completion of R. Matsumura has shown that $n - 1$ is the maximal height possible for prime ideals P of $\widehat{R}$ such that $P \cap R = (0)$. We show, if $\phi : (R, \mathbf{m}) \hookrightarrow (S, \mathbf{n})$ is an injective local map of Noetherian local integral domains and the following five properties hold:

(1) $\mathbf{m}S$ is $\mathbf{n}$-primary, and $S/\mathbf{n}$ is finite algebraic over $R/\mathbf{m}$,

(2) $R \hookrightarrow S$ is a TGF-extension and $\dim R = \dim S$,

(3) R is analytically irreducible,

(4) R is analytically normal and S is universally catenary,

(5) All maximal ideals of the generic formal fiber of R have the same height,

then the maximal ideals of the generic formal fiber of S all have height the dimension of the generic formal fiber of R.

It follows that in the situation of Matsumura's theorem, ht $P = n - 1$, for every prime ideal P of $\widehat{R}$ that is maximal with respect to $P \cap R = (0)$. We also discuss related results, past and current, regarding formal fibers. (Received August 07, 2013)

1094-13-96 **Jennifer Biermann** and **Chris Francisco*** (chris@math.okstate.edu), Department of Mathematics, Oklahoma State University, 401 MSCS, Stillwater, OK 74078, and **Huy Tài Hà** and **Adam Van Tuyl**. *Partially whiskering a simplicial complex.*

As Villarreal demonstrated by attaching whiskers to each vertex of a graph, making small modifications to a simplicial complex can have a significant effect on the combinatorial topology and on the algebraic properties of associated ideals. We extend work of Hà and the speaker on whiskering graphs and work of Biermann and Van Tuyl on fully-whiskered simplicial complexes to give a necessary and sufficient condition for a partially-whiskered simplicial complex to be vertex decomposable. (Received August 13, 2013)

1094-13-130 **Soumya Deepta Sanyal*** (sds2p8@mail.missouri.edu). *Irrational behavior of algebraic discrete valuations dominating regular local rings of dimension two.*

We present new results on Hilbert functions of discrete algebraic valuations dominating a regular local ring of dimension two. We show non-polynomial behavior of the Hilbert function, as well as irrationality of the associated multiplicity. (Received August 18, 2013)

1094-13-136 **David Wright*** (wright@math.wustl.edu). *Local criteria for stable tameness of polynomial automorphisms.*

A fairly recent breakthrough in the field of polynomial automorphisms establishes that all two dimensional automorphisms over a regular ring are stably tame. The proof uses some tools of intrinsic interest, including assertions that stable tameness can be detected at the local level and at the level of fibers. The proofs of these tools evoke arguments reminiscent of parts the proof of the Quillen-Suslin Theorem and other results of that era, including the theorem of Bass-Connell-Wright which asserts n-space bundles are vector bundles over affine schemes. This talk will lay out the recent results and discuss the similarity of the localization methods used here with those of previous results. (Received August 19, 2013)

1094-13-197 **Ian M Aberbach*** (aberbachi@missouri.edu), Department of Mathematics, University of Missouri, Columbia, MO 65211, and **Aline Hosry** and **Janet Striuli**. *Uniform Artin-Rees results for resolutions.* Preliminary report.

Let (R, m) be a local Noetherian ring. Huneke and Eisenbud raised the question of if, given a finitely generated module M, there exists a uniform Arin-Rees number, i.e., if there exists a $t > 0$ such that for all ideals I and all syzygies of M, $N \subseteq F$ (where F is free), we have $I^n F \cap N \subseteq I^{n-t} N$. They proved some cases where this occurs, and Striuli proved the result when R has dimension one or two. We will outline here how a much more general result holds. (Received August 23, 2013)

1094-13-198 **Hailong Dao*** (hdao@math.ku.edu), **Ilya Smirnov** and **Kei-ichi Watanabe**. *Higher Hilbert-Kunz Theory.*

Let (R, m) be a ring of positive characteristic with $d = \dim R$ and I be an ideal in R which is m-primary. The classical Hilbert-Kunz multiplicity is the limit of $\frac{\lambda(R/I^{[p^e]})}{p^{de}}$ as e tends to infinity. In our work we consider any finitely generated module M, and replace the length of $R/I^{[p^e]}$ by the length of some local cohomology of the module $F^e(M)$, here F is the Peskine-Szpiro functor. This generalizes the classical notion in many ways. We can prove that the limit exists over isolated singularities (with some mild extra conditions) and more interestingly, classify when the limit is 0 over complete intersections or F-regular rings. Some applications will be discussed. (Received August 23, 2013)

1094-13-211 **Olgur Celikbas*** (celikbaso@missouri.edu), University of Missouri, Columbia, MO 65211, and **Greg Piepmeyer**. *Syzygies and tensor product of modules.*

If R is a local hypersurface (a commutative Noetherian ring that is a complete intersection of codimension one) and M and N are nonzero finitely generated R-modules such that either M or N has a rank, and $M \otimes_R N$ is a second syzygy module, then a remarkable theorem of Huneke and Wiegand (referred as the second rigidity theorem) states that the pair (M, N) is Tor-independent, and this implies that both M and N are first syzygy modules.

In a recent joint work with Greg Piepmeyer (Syzygies and tensor product of modules; to appear in Math. Zeitschrift, posted at arxiv:1210.4767), we are able to obtain a partial generalization of the second rigidity theorem over complete intersections of arbitrary codimension:

Let R be a local complete intersection of codimension c and let M and N be nonzero finitely generated R-modules. Assume $M \otimes_R N$ is an $(n + c)$th syzygy module for some nonnegative integer n. Assume further that the pair (M, N) is Tor-independent. Then both M and N are nth syzygy modules.

Our argument obtains the aforementioned result for homologically bounded complexes of finitely generated modules; a new twist we use of is a version of the New Intersection Theorem developed by Sharif and Yassemi. (Received August 23, 2013)

1094-13-224 **H. Ananthnarayan** and **E. Celikbas*** (celikbase@missouri.edu), 114 Math Sciences Building, Mathematics Department, University of Missouri, Columbia, MO 65211, and **Z. Yang**. *Connected sums of k-algebras.*

A connected sum, initially introduced by H. Ananthnarayan, L. Avramov, and F. Moore, is a construction that can be used to produce Gorenstein rings. In this talk we discuss a characterization of connected sums of k-algebras, and some relations between associated graded rings and connected sums. In particular, we observe that a Gorenstein Artin k-algebra with certain conditions on its associated graded ring is a connected sum. (Received August 25, 2013)

1094-13-243 **Purnaprajna P Bangere***, purna@ku.edu. *Syzygies and Geometry.*

The topic of syzygies of projective varieties has attracted attention. For some, the interest in this topic comes from the connection with geometry. The main desire is to read off a geometric invariant from the algebra of free resolution of the homogeneous coordinate ring under a suitable embedding. Some interesting results have been proved for the case of an algebraic curve. But for higher dimensional varieties not much is known. In this talk, we will discuss some results connecting geometry of the embedding to the algebra of free resolutions for the case of an algebraic surface. These results give first instances of connection between classical geometric entities to the more modern theme of syzygies of a projective variety. (Received August 25, 2013)

1094-13-245 **Florian Enescu*** (fenescu@gsu.edu), Department of Mathematics and Statistics, 758 COE, Georgia State University, 30 Pryor Street, Atlanta, GA 30303, and **Yongwei Yao** (yyao@gsu.edu), Department of Mathematics and Statistics, Georgia State University, 30 Pryor Street, Atlanta, GA 30303. *The Frobenius complexity of a local ring.* Preliminary report.

In this talk I will study the ring of Frobenius operators on the injective hull of the residue field of a local ring of prime characteristic. I will then define the Frobenius complexity of a local ring and present basic results about this concept. This is joint work with Yongwei Yao. (Received August 25, 2013)

1094-13-285 **Christel Rotthaus*** (rotthaus@math.msu.edu), Michigan State University, Department of Mathematics, East Lansing, MI 48824, **William Heinzer**, Purdue University, Department of Mathematics, **Liana Sega**, University of Missouri - Kansas City, Department of Mathematics, and **Sylvia Wiegand**, University of Nebraska - Lincoln, Department of Mathematics. *A class of non-Noetherian rings.*

During the last decade my coauthors and I have studied a certain class of non-Noetherian (and Noetherian)domains. These examples are constructed as a nested countable union of local Noetherian domains and are fairly easy to control. In the Noetherian case the construction has produced a number of interesting examples and counterexamples in commutative algebra. In this talk we intend to give a survey about what is known (so far) in the non-Noetherian case. (Received August 26, 2013)

1094-13-286 **Vinh An Pham*** (vapnnc@mail.missouri.edu), Mathematics Department, University of Missouri-Columbia, Columbia, MO 65211. *Stable Forms of Extensions of Local Rings along a Valuation.*

Let K^*/K be a finite extension of algebraic function fields over a field k and ν^* a be k-valuation of K^* with restriction ν to K. Let R and S be algebraic local rings of K and K^* respectively, such that ν^* dominates S and S dominates R. Using the filtrations on R and S by elements of value larger than or equal to a fixed element of the value group, we have associated graded rings $\mathrm{gr}_\nu(R)$ and $\mathrm{gr}_{\nu^*}(S)$, which are generally non Noetherian. For function fields of algebraic surfaces over algebraically closed fields k of characteristic zero, Ghezzi, Ha and Kashcheyeva have shown that under finite sequences of quadratic transforms along ν^* and ν, $\mathrm{gr}_{\nu^*}(S)$ is eventually finitely generated over $\mathrm{gr}_\nu(R)$, and has a simple toric form. Our main result is to generalize this to the case of arbitrary ground field of characteristic zero. This is a joint work with Steven Dale Cutkosky. (Received August 26, 2013)

1094-13-287 **Justin C Hoffmeier*** (jche60@mail.umkc.edu) and **Liana Sega**. *Generalized Koszul properties of compressed Gorenstein local rings.* Preliminary report.

Compressed Gorenstein local rings have been considered recently in work of Rossi and Şega; they are defined as those local rings $(R, \mathfrak{m}, k)$ of maximal length among all local Gorenstein Artinian rings of socle degree s, where $\mathfrak{m}^{s+1} = 0 \neq \mathfrak{m}^s$, and embedding dimension $e = \mathrm{rank}_k(\mathfrak{m}/\mathfrak{m}^2)$. When $s = 2$ such rings are Koszul, in the sense that the associated graded ring with respect to $\mathfrak{m}$ is a Koszul algebra. We prove that when $s > 2$ and s is even these rings satisfy various properties which can be understood as *generalized Koszul properties*. In particular, the Yoneda algebra $\mathrm{Ext}_R(k, k)$ is generated in degrees 1 and 2. (Received August 26, 2013)

1094-13-298 **Kristen A Beck**, **Petter Andreas Bergh**, **David A Jorgensen*** (djorgens@uta.edu) and **Frank Moore**. *Approximations of totally acyclic complexes.* Preliminary report.

Let Q be a commutative local ring, I an ideal of Q having finite projective dimension, and $R = Q/I$. In this talk we define an adjoint pair of exact functors between the homotopy category of totally acyclic complexes over Q and that over R. As a consequence, one obtains a systematic notion of approximation of a totally acyclic complex over R by a totally acyclic complex over Q. In particular, we show how one may approximate a totally acyclic complex over a complete intersection by a matrix factorization. This is based on joint work with Kristen Beck, Petter Bergh, and Frank Moore. (Received August 26, 2013)

1094-13-316 **Christopher Francisco**, **Jeff Mermin*** (mermin@math.okstate.edu) and **Jay Schweig**. *An unsatisfying bijection.*

Let I be the smallest Borel-fixed ideal containing the monomial $x_1x_2\cdots x_n$. Recently we discovered that the graded Betti numbers of I count the pointed pseudo-triangulations of a geometric configuration called the *single chain*. The connection was purely numerical, so shed no light on the combinatorial structure of either object. Now, we define bijections connecting pointed pseudo-triangulations, marked binary trees, and a basis for the resolution of I. These bijections are unsatisfying in the sense that the differential from the resolution does not appear to correspond to a natural map on pointed pseudo-triangulations. (Received August 26, 2013)

1094-13-360 **Catalin Ciuperca*** (catalin.ciuperca@ndsu.edu), North Dakota State University, Mathematics Department 2750, PO Box 6050, Fargo, ND 58108-6050. *Limit multiplicities for pairs of ideals.* Preliminary report.

Let (R, m) be a formally equidimensional local ring of dimension d and $J \subseteq I$ a pair of ideals. For n large, the R-modules I^n/J^n have constant dimension t and multiplicity $f(n)$. We discuss the limit $\lim_n f(n)/n^{d+t}$. (Received August 27, 2013)

1094-13-390 **Fatih Koksal*** (fatih.koksal@ttu.edu). *Injective Modules under Faithfully Flat Ring Extensions.* Preliminary report.

Faithfully flat ring extensions play an important role in commutative algebra. Given an R-algebra S it is well-known that if N is an injective R-module then $\mathrm{Hom}_R(S, N)$ is an injective S-module. Is the converse true? The answer is no, even when R is a regular local ring and S is its completion. In this talk I will prove the following: Let $\varphi : R \to S$ be a faithfully flat ring homomorphism of noetherian rings with finite Krull dimension. Let N be an R-module. If $\mathrm{Hom}_R(S, N)$ is an injective S-module and $\mathrm{Ext}^{>0}_R(S, N) = 0$, then N is an injective R-module. (Received August 27, 2013)

14 ► Algebraic geometry

1094-14-64 **Ravindra Girivaru***, Department of Math and CS, 1 University Blvd, University of Missouri, St. Louis, MO 63121, and **Deepam Patel**. *Infinitesimal Lefschetz theorems for Chow groups.*

The Bloch-Beilinson conjectures describe the structure of Chow groups of smooth, projective varieties. One consequence of this is an analogue of the Grothendieck-Lefschetz theorem for Chow groups of higher codimension cycles. A similar analogue for the Noether-Lefschetz theorem has been conjectured by Nori. I will talk about some recent work done in this context.

This is joint work with Deepam Patel. (Received August 07, 2013)

1094-14-108 **Zhiyu Tian***, Mathematics, 253-37, Caltech, Pasadena, CA 91125. *One cycles on rationally connected varieties.*

This is joint work with Hong R. Zong (Princeton).

Motivated by the integral Hodge conjecture and related questions for rationally connected varieties, we studied one cycles on (separably) rationally connected varieties. The main result is that the Chow group of one cycles is generated by rational curves. When the variety is a Fano complete intersection of index at least 2, the Chow group of one cycles is generated by lines. As a corollary, the Griffiths group is trivial for these Fano complete intersections. (Received August 15, 2013)

1094-14-114 **Steven Dale Cutkosky*** (cutkoskys@missouri.edu), Dept. Math., University of Missouri, Columbia, MO 65211. *Teissier's problem on inequalities of nef divisors.*

Teissier has proven remarkable inequalities $s_i^2 \geq s_{i-1}s_{i+1}$ for intersection numbers $s_i = (\mathcal{L}^i \cdot \mathcal{M}^{d-i})$ of a pair of nef line bundles $\mathcal{L}$, $\mathcal{M}$ on a d-dimensional complete algebraic variety over a field. He asks if two nef and big line bundles are numerically proportional if the inequalities are all equalities. In this paper we show that this is true in the most general possible situation, for nef and big line bundles on a proper irreducible scheme over an arbitrary field k. Boucksom, Favre and Jonsson have recently established this result on a complete variety X over an algebraically closed field of characteristic zero. Their proof involves on ingenious extension of the intersection theory on a variety to its Zariski Riemann Manifold. Their proof requires the existence of a direct system of nonsingular varieties dominating X. We make use of a simpler intersection theory which does not require resolution of singularities, and extend volume to an arbitrary field and prove its continuous differentiability, extending results of Boucksom, Favre and Jonsson, and of Lazarsfeld and Mustaţă. (Received August 16, 2013)

1094-14-131 **James Dominic Lewis*** (lewisjd@ualberta.ca), Dept of Mathematics, University of Alberta, Edmonton, AB T6G 2G1, Canada. *A Variation of the Beilinson-Hodge Conjecture.* Preliminary report.

Based on some recent work of Lewis and de Jeu, we formulate a variation of the Beilinson-Hodge conjecture pertaining to varieties defined over the complex numbers. In this talk, we explain the motivation for this conjecture, and some evidence in support of it.
(Received August 18, 2013)

1094-14-177 **Haohao Wang*** (hwang@semo.edu), Math Department, MS6700, Cape Girardeau, MO 63701, and **Xiaohong Jia** and **Ron Goldman**. *Set-Theoretic Generators of Rational Space Curves.*

We show how to calculate three low degree set-theoretic generators (i.e., algebraic surfaces) for all rational space curves of low degree (degree ≤ 6) as well as for all higher degree rational space curves where at least one element of their μ-basis has degree 1 from a μ-basis of the parametrization. In addition to having low degree, at least two of these surface generators are always ruled surfaces. Whenever possible we also show how to compute two set-theoretic complete intersection generators for these rational space curves from a μ-basis of their parametrization.
(Received August 22, 2013)

1094-14-180 **Eric Katz*** (eekatz@uwaterloo.ca), 200 University Avenue West, Waterloo, Ontario N2L 3G1, Canada. *The Hodge Theory of Degenerating Hypersurfaces.*

Geometric properties of generic hypersurfaces in projective toric varieties are often determined by their corresponding Newton polytopes. Pioneering work of Danilov-Khovanskii gave combinatorial descriptions for their Euler characteristic and χ_y-characteristic in terms of combinatorics. In joint work with Alan Stapledon, we outline an alternative approach to hypersurfaces. Here, we degenerate the hypersurface into a union of linear

subspaces and use the limit mixed Hodge structure to understand the cohomology. We also discuss some applications to Ehrhart theory as well as the combinatorial analogues of normal crossings compactifications and semistable reduction. (Received August 22, 2013)

1094-14-206 **Matthew Robert Ballard*** (ballard@math.sc.edu), University of South Carolina, Department of Mathematics, 1523 Greene Street, Columbia, SC 29208, and **David Favero** and **Ludmil Katzarkov**. *Kernels for Equivariant Factorizations, I.*

The bounded derived category of coherent sheaves, $D^b(X)$, is, in a natural way, a categorification of the Hodge cohomology of variety, X. Given two varieties, X and Y, $D^b(X \times Y)$ categorifies correspondences between X and Y. As such, one often calls the objects of $D^b(X \times Y)$ kernels. Kontsevich's world of non-commutative geometry expands the horizons of algebraic geometry to include many new geometric objects. Those closest to commutative world are Landau-Ginzburg models: varieties equipped with a regular function. A natural question is to determine what are correspondences, or better yet, kernels, between LG models. In this talk, we will describe kernels for equivariant LG models. In the sequel, by David Favero, some applications will be provided. (Received August 23, 2013)

1094-14-216 **Adrian Clingher***, 350 Express Scripts Hall, One University, St. Louis, MO 63121. *K3 Surfaces of High Picard Rank.*

I will discuss a few special families of K3 surfaces of high Picard rank, from the point of view of the Kuga-Satake construction. (Received August 24, 2013)

1094-14-219 **Elham Izadi*** (eizadi@math.ucsd.edu), Department of Mathematics, 9500 Gilman Drive, University of California, San Diego, La Jolla, CA 92093-0112. *The primitive cohomology of theta divisors.*

In joint work with Csilla Tamas and Jie Wang, we prove that the primitive cohomology of the theta divisor of an abelian fivefold satisfies the general Hodge conjecture, i.e., it is contained in the image of the cohomology of a threefold via a Gysin map. (Received August 24, 2013)

1094-14-228 **Francisco J Gallego**, **Gonzalez Miguel** and **Purnaprajna P Bangere***, purna@ku.edu. *Deformations of canonical morphism and the moduli of surfaces of general type.*

Abstract: I will talk about the deformation of finite maps and show how to use this deformation theory to construct varieties with given invariants in a projective space. Among other things, we prove a criterion that determines when a finite map can be deformed to a one–to–one map. We use this criterion to construct new simple canonical surfaces–so-called by the Italian geometer Enriques– with different c_1^2 and χ. Our general results enable us to describe some new components of the moduli of surfaces of general type. We also find infinitely many moduli spaces $\mathcal{M}_{(x',0,y)}$ having one component whose general point corresponds to a canonically embedded surface and another component whose general point corresponds to a surface whose canonical map is a degree 2 morphism, a situation that is quite different from the case for curves or surfaces such as K3. (Received August 25, 2013)

1094-14-256 **David Rudy Favero*** (favero@gmail.com), 8210-111 Street, Suite 2708, Edmonton, Alberta T6G2C7, Canada. *Kernels for Equivariant Factorizations II: Griffiths' Theorem.*

I will explain a categorical proof of Griffiths' classical description of the primitive cohomology of a smooth, complex projective hypersurface in terms of homogeneous pieces of its Jacobian algebra. The ingredients involved are the internal description of the functor category between equivariant factorizations discussed by M. Ballard, together with a theorem of Orlov and the Hochschild-Kostant-Rosenberg isomorphism. (Received August 26, 2013)

1094-14-367 **Patrick Gerald Brosnan*** (pbrosnan@umd.edu), Department of Mathematics, University of Maryland, College Park, MD 20742-4015. *Kashiwara conjugation for twisted D-modules.* Preliminary report.

Suppose X is a complex manifold and λ is a closed $(1,1)$ form on X. Then one can twist the ring D_X of holomorphic differential operators on X using the class λ to arrive at a ring $D_{X,\lambda}$. I'll explain how to use λ to embed the twisted ring $D_{X,\lambda}$ in the ring of all smooth differential operators on X. Using this, I explain how to prove a twisted analogue of a theorem of Kashiwara relating D-modules on X to D modules on the complex conjugate of X. In the case that X is a projective homogeneous space, there was already a twisted version proved by Barlet and Kashiwara. But, even in this case, the arguments I present seem simpler and more explicit. (Received August 27, 2013)

1094-14-375 **Sen Yang*** (syang5@math.lsu.edu), Department of Mathematics, LSU, Baton Rouge, LA 70803. *Higher algebraic K-theory and tangent spaces to Chow groups.*

Around 2000, Green-Griffiths initiated the study of geometric tangent spaces of Chow groups. Guided by geometry, they posed a list of related questions on their Annals study book-157.

We will present an answer to one of their questions, which says the tangent sequence of Bloch-Gersten-Quillen sequence is Cousin resolution, by using higher K-theory, negative cyclic homology, Chern character and etc. We will also use K3 and Calabi-Yau 3-fold to explain two new features: appearance of negative K-groups and the necessary use of Adams operations. Joint work with J. W. Hoffman together with B. Dribus. (Received August 27, 2013)

15 ► Linear and multilinear algebra; matrix theory

1094-15-292 **Jameson Cahill*** (jcahill@math.duke.edu), **Dustin G. Mixon** and **Nate Strawn**. *Geometry of equal norm tight frames.*

We will discuss several questions about the geometry of the space of equal norm tight frames. First we will show that this space is connected, which answers a long standing open problem. Next we will argue that as an algebraic variety this space is irreducible; this was and unexpected result. From this we can show that a generic equal norm tight frame is full spark. (Received August 26, 2013)

1094-15-377 **Afonso S. Bandeira**, **Matthew Fickus**, **Dustin G. Mixon*** (dustin.mixon@gmail.com) and **Joel Moreira**. *A new approach to derandomize compressed sensing matrices.*

The restricted isometry property (RIP) is a compressed sensing matrix specification which leads to performance guarantees for a wide variety of sparse signal reconstruction algorithms. For the sake of quality sensing standards, practitioners desire deterministic sensing matrices, but the best known deterministic RIP matrices are vastly inferior to those constructed using random processes. This talk presents a new way to pursue good deterministic RIP matrices. Taking inspiration from certain work in number theory and discrepancy theory, we consider particular notions of pseudorandomness in a sequence, and we populate a sensing matrix with consecutive members of such a sequence, starting at a random member of the sequence. To demonstrate RIP, we chiefly leverage the sequence's pseudorandomness so that very little randomness is needed to seed the construction. We suspect that a more refined notion of pseudorandomness will completely derandomize this construction. (Received August 27, 2013)

16 ► Associative rings and algebras

1094-16-10 **Vladimir Bavula*** (v.bavula@sheffield.ac.uk), School of Mathematics and Statistics, University of Sheffield, Sheffield, United Kingdom. *New criteria for a ring to have a semisimple left quotient ring.*

Goldie's Theorem (1960), which is one of the most important results in Ring Theory, is a criterion for a ring to have a semisimple left quotient ring (i.e. a semisimple left ring of fractions). The aim of my talk is to give four new criteria (using a completely different approach and new ideas). The first one is based on the recent fact that for an arbitrary ring R the set of maximal left denominator sets of R is a non-empty set. The Second Criterion is given via the minimal primes of R and goes further then the First one in the sense that it describes explicitly the maximal left denominator sets via the minimal primes of R. The Third Criterion is close to Goldie's Criterion but it is easier to check in applications (basically, it reduces Goldie's Theorem to the prime case). The Fourth Criterion is given via certain left denominator sets. (Received June 05, 2013)

1094-16-11 **Zak Mesyan***, Department of Mathematics, University of Colorado, Colorado Springs, CO 80918. *Generalizations of Shoda's Theorem.*

A celebrated theorem of Shoda from 1936 states that over any field (of characteristic 0), every matrix with trace 0 can be expressed as a commutator AB-BA. I will describe various attempts to generalize this result over the years. (Received June 06, 2013)

1094-16-38 **A Alahamadi** and **S K Jain***, Department of Mathematics, Ohio University, Athens, OH 45701, and **Surjeet Singh**. *Local Almost Self-Injective Rings.* Preliminary report.

Let M_R, N_R be two modules. M is said to be almost N-injective, if for any homomorphism $f : X \to M$, $X \leqslant N$, either f extends to a homomorphism $g : N \to M$ or there exists a homomorphism $h : M \to N_1$ such that

$hf = \pi i$, where $i : X \to N$ is an inclusion map, $N = N_1 \oplus N_2$,is some decomposition of N with $N_1 \neq 0$ and $\pi : N \to N_1$is a projection onto N_1.

Theorem A. Let R be a local ring with $J(R)$ a nil ideal. If R is right almost R-injective (called almost right self-injective) and $soc(R_R) \neq 0$, then R is right self-injective. In particular, left perfect right almost self-injective is right self-injective.

Theorem B. Let R be a ring having no nontrivial idempotent.If it satisfies a condition that given any homomorphism $f : A \to R$, where $A \leqslant R_R$, either f extends from R to R or there exists a homomorphism $h : R \to A$ such that $hf = i_A$. Then R is right self-injective.

Example is given to show that, in general, a right almost self-injective local ring need not be right self-injective. The structure of semiperfect right almost self-injective rings is being studied. (Received July 24, 2013)

1094-16-40 **Manuel Lionel Reyes*** (reyes@bowdoin.edu), Bowdoin College, Department of Mathematics, 8600 College Station, Brunswick, ME 04011. *Sheaves that fail to represent matrix rings.*

There are two fundamental obstructions to representing noncommutative rings via sheaves. First, there is no subcanonical coverage on the opposite of the category of rings that includes all covering families in the big Zariski site. Second, there is no contravariant functor F from the category of rings to the category of ringed categories whose composite with the global sections functor is naturally isomorphic to the identity, such that F restricts to the Zariski spectrum functor Spec on the category of commutative rings (in a compatible way with the natural isomorphism). Both of these no-go results are proved by restricting attention to matrix rings. (Received July 24, 2013)

1094-16-47 **W. Keith Nicholson*** (wknichol@ucalgary.ca), Department of Mathematics & Statistics, University of Calgary, Calgary, Alberta T2N 1N4, Canada. *Stability and Unique Generation.* Preliminary report.

An element a in a ring R is said to be left uniquely generated (left UG) if Ra=Rb in R implies that a=ub for some unit u∈R, and R is a left UG ring if every element is left UG.

THEOREM The following are equivalent for an exchange ring R: (1) All idempotents are left UG; (2) Every regular element of R is unit regular; (3) R has stable range 1.

Call R a left PAP ring if every left annihilator l(a), a∈R, is a principal left ideal.

THEOREM If R is a left PAP ring, then R is a left UG ring if and only if R has stable range 1. (Received July 31, 2013)

1094-16-56 **André G. Leroy*** (andre.leroy@univ-artois.fr), Université d'Artois, Faculté Jean Perrin, Rue Jean Souvraz, 62300 Lens, France. *Pseudo-linear transformations, coding theory and factorizations in Ore extensions.*

In this talk we will explain why the skew polynomial rings $\mathbb{F}_q[t;\theta]$ where θ is the Frobenius automorphism have influenced coding theory in recent years. We will then show how pseudo-linear transformations quickly allow general Ore extensions $R = A[t;\sigma,\delta]$, A a finite ring, to be used in order to define codes. The factorizations process of polynomials over R is important and we will see two ways of attaching a classical commutative polynomial to each polynomial $p(t) \in k[t;\sigma]$, k a finite field, in such a way that commutative factorizations can be used to obtain factorizations of $p(t)$. We will conclude the talk by indicating some generalizations of the classical notion of exponent of a polynomial with coefficients over a finite field. (Received August 06, 2013)

1094-16-81 **Liping Li*** (lipingli@math.ucr.edu), 900 University Avenue, Surge 243, Riverside, CA. *Representations of modular skew group algebras.*

Skew group algebras naturally generalize ordinary group algebras. Let A be a finite dimensional algebra and let G be a finite group whose elements acting on A as algebra automorphisms. It has been shown that the skew group algebra AG and A share many important properties (such as finite representation type, finite global dimension, etc) if the order of G is invertible. However, when the order of G is not invertible, many results fail. Therefore, it is natural to ask under what conditions AG and A still share these properties for arbitrary G. The answer of this question will be described in this talk. (Received August 11, 2013)

1094-16-93 **Edgar Enochs**, Department of Mathematics, University of Kentucky, Lexington, KY 40506, **Sergio Estrada*** (sestrada@um.es), Departamento de Matemática Aplicada, Campus del Espinardo, 30100 Murcia, Spain, and **Sinem Odabasi** (sinem.odabasi1@um.es), Departamento de Matemáticas, Campus del Espinardo, 30100 Murcia, Spain. *Pure injective and absolutely pure sheaves.* Preliminary report.

We study two notions of purity in categories of sheaves: the categorical and the geometric. It is shown that pure injective envelopes exist in both cases under very general assumptions on the scheme. Finally we introduce the class of locally absolutely pure (quasi–coherent) sheaves, with respect to the geometrical purity, and characterize locally Noetherian closed subschemes of a projective scheme in terms of the new class.

The presenting author is supported by the Spanish Ministry of Economy and Competitiveness and FEDER funds. (Received August 13, 2013)

1094-16-125 **Nicholas J Werner*** (nwerner@newark.osu.edu). *Generalizations of Integer-valued Polynomials.*

Given a commuatative integral domain D with field of fractions k, the classical ring of integer-valued polynomials over D is $\mathrm{Int}(D) := \{f(x) \in k[x] \mid f(D) \subseteq D\}$. A problem of current interest is to study a generalization of this construction to sets of polynomials that act on D-algebras. When A is a torsion-free D-algebra that is finitely generated as a D-module, we define $\mathrm{Int}(A) := \{f(x) \in B[x] \mid f(A) \subseteq A\}$, where B is the extension of A to a k-algebra. The set $\mathrm{Int}(A)$ consists of polynomials with non-commuting coefficients and is always a left A-module. In certain cases (such as when A is a matrix algebra or a group ring) $\mathrm{Int}(A)$ is actually a ring, although it is not known whether this is true in general. We will discuss the current state of knowledge on $\mathrm{Int}(A)$ and other associated objects; present some interesting connections that arise involving commutative rings, noncommutative rings, and finite rings; and mention open problems and avenues for future research. (Received August 17, 2013)

1094-16-133 **Abdullah Harmanci** and **Sergio R López-Permouth*** (lopez@ohio.edu), Department of Mathematics, 321 Morton Hall, Athens, OH 45701, and **Burcu Ungor**. *On the Pure-Injectivity Profile of a Ring.*

An analog of the injective profile of a ring, with relative injectivity replaced by relative pure-injectivity, is investigated. Emphasis is placed on comparing and contrasting the properties of the injective profile and the pure-injective profile introduced here. In particular, the analog notion of poor modules in this context is considered and properties of pure-injectively poor modules are determined. Also, some characterizations of right pure-semisimple rings are obtained in terms of the notion of pure-injectively poor modules. (Received August 19, 2013)

1094-16-157 **Pedro Antonio Guil Asensio*** (paguil@um.es), Department of Mathematics., University of Murcia, 30100 Murcia, Murcia, Spain, **Derya Keskin Tutuncu**, , Turkey, and **Ashish Srivastava**. *Modules invariant under automorphisms of their covers and envelopes.*

We develop a general theory of modules which are invariant under automorphisms of their covers and envelopes. When applied to specific cases like injective envelopes, pure-injective envelopes, cotorsion envelopes, projective covers, or flat covers, these results extend and provide a much more succinct and clear proofs for various results existing in the literature. Our results are based on several key observations on the additive unit structure of von Neumann regular rings. (Received August 21, 2013)

1094-16-172 **Hamid Usefi*** (usefi@mun.ca), Department of Mathematics and Statistics, Memorial University of Newfoundland, St John's, NL A1C5S7, Canada. *The interplay between group algebras and enveloping algebras.*

Let $\mathbb{F}G$ and $\omega(G)$ be the group algebra and augmentation ideal of a group G over a field $\mathbb{F}$ of characteristic p, respectively. We first recall a theorem of Quillen stating that the graded algebra associated to $\mathbb{F}G$ is isomorphic as an algebra to the enveloping algebra of the restricted Lie algebra associated to the dimension series of G. We then extend a theorem of Jennings that provides a basis for the quotient $\omega^n(G)/\omega^{n+1}(G)$ in terms of a basis of the restricted Lie algebra. Finally, we present some applications of these theorems. (Received August 22, 2013)

1094-16-188 **Nguyen Viet Dung*** (nguyend2@ohio.edu), Department of Mathematics, Ohio University, Zanesville Campus, Zanesville, OH 43701, and **José Luis García** (jlgarcia@um.es), Department of Mathematics, University of Murcia, 30100 Murcia, Spain. *Splitting torsion pairs over pure semisimple rings.*

For a left Artinian ring R, a splitting torsion pair of R-ind is a partition $(\mathcal{D}, \mathcal{C})$ of the family R-ind of all non-isomorphic finitely generated indecomposable left R-modules such that $Hom_R(D, C) = 0$ whenever $D \in \mathcal{D}$ and $C \in \mathcal{C}$. If R is a left pure semisimple ring, i.e. a ring R such that every left R-module is a direct sum of finitely

generated (indecomposable) left R-modules, we show that splitting torsion pairs have many nice properties. For example, if $\mathcal{D}$ contains all indecomposable injective left R-modules, then the endomorphism ring of each module in $\mathcal{C}$ is a division ring. Splitting torsion pairs occur naturally in several contexts, and when R is left pure semisimple hereditary, splitting torsion pairs of R-ind can be characterized using the Ext-injective partition of R-ind. Among the consequences, we obtain descriptions of indecomposable direct summands of tilting left R-modules having hereditary endomorphism rings. (Received August 22, 2013)

1094-16-230 **Kulumani M. Rangaswamy*** (ranga@uccs.edu), Deaprtment of Mathematics, University of Colorado at Colorado Springs, Colorado Springs, CO 80918. *On non-graded ideals of Leavitt path algebras over arbitrary graphs.*

Let L denote the Leavitt path algebra of an arbitrary graph E over the field K. Non-graded ideals of L are described by means of their generators. L has either no or infinitely many non-graded ideals. In latter case, the cardinlity of the non-graded ideals of L is computed. (Received August 25, 2013)

1094-16-284 **Dolors Herbera***, Departament de Matematiques, Universitat Autonoma de Barcelona, E08193 Bellaterra, Barcelona, Spain, and **Javier Sanchez Sarda**, Department of Mathematics - IME, University of Sao Paulo, Sao Paulo, SP 05314-970, Brazil. *Inversion height, rational series and crossed products.*

Let $\varepsilon\colon R \hookrightarrow F$ be an embedding of a non-necessarily commutative domain R into a (skew) field F. The subfield of F generated by R is $L = \bigcup_{n\geq 0} R_n$ where $R_0 = R$ and, for $n \geq 1$, R_n is the subring of F generated by the elements of R_{n-1} and the inverses of nonzero elements of R_{n-1}. The inversion height of ε is infinite if the chain

$$R_0 \subseteq R_1 \subseteq \cdots \subseteq R_n \subseteq \cdots$$

is not stationary. Otherwise, the inversion height of ε is finite.

Let X be a set with at least two elements, and let k be any commutative field. We prove that the inversion height of the embedding $k\langle X\rangle \hookrightarrow D$, where D denotes the universal division ring of fractions of the free algebra $k\langle X\rangle$, is infinite. Therefore, if H denotes the free group on X, the inversion height of the embedding of the group algebra $k[H]$ into the Mal'cev Neumann series ring is also infinite. This answers in the affirmative a question posed by Neumann in 1949.

The case of an infinite set X was already settled by Reutenauer in 1996 (Received August 26, 2013)

1094-16-324 **Gangyong Lee**, **S. Tariq Rizvi** and **Cosmin Roman*** (cosmin@math.osu.edu), The Ohio State University, Lima, Galvin Hall 4th, 4240 Campus Dr., Lima, OH 45804. *Characterizing modules via their endomorphism ring.*

In studying a module over a ring R, finding what properties its corresponding endomorphism ring will have is of high interest. On the other hand, one can go in the opposite direction, completely characterizing a module via its endomorphism ring. In my talk I will present a survey of module-theoretic properties, which can be obtained in this fashion. These properties include injectivity and its various generalizations, nonsingularity of different kinds, Baer and Rickart properties, module-theoretic von Neumann regularity, and others.

This presentation is based on work with G. Lee and S.T. Rizvi. (Received August 26, 2013)

1094-16-337 **Dinh V Huynh*** (huynh@ohio.edu), Department of Mathematics, Ohio University, Athens, OH. *Nonsemiprime Rings Over Which Quasi-Projectives Are Semisimple or Projective.*

In this talk we discuss the question: What kind of rings R has the property that every quasi-projective right R-module is either projective or semisimple? We call these rings, right QPSP-rings. Theorem 1. Let R be a nonsemiprime indecomposable ring. Then R is right QPSP if and only if it is either a right Artinian right SI-ring with $R = e_1R \oplus \cdots \oplus e_nR$ where $\{e_i\}_{i=1}^n$ is a system of orthogonal primitive idempotents, for each $e_iR,\ \ell(e_iR) \leq 2$; or R is a right Artinian ring with $R = e_1R \oplus \cdots \oplus e_nR$ where for $1 \leq i,\ j \leq n,\ e_iR \cong e_jR$.

Theorem 2. For an indecomposable nonsemiprime ring R, the following are equivalent:

(1) R is a right QPSP-ring and every minimal submodule of $(R \oplus R)_R$ is essential in a direct summand.

(2) R is a left QPSP-ring and every minimal submodule of ${}_R(R \oplus R)$ is essential in a direct summand.

(3) R is either

(3_1) An Artinian serial, SI-ring with $J(R)^2 = 0$ and for each uniform right (left) ideal $U,\ \ell(U) \leq 2$, or

(3_2) A Frobenius ring with $J(R)^2 = 0$, having (up to isomorphism) only one singular simple right (left) module.

(4) R is a left and right QPSP-ring. (Received August 27, 2013)

1094-16-363 **Feroz Siddique*** (fsiddiq2@slu.edu), Saint Louis University, Dept. Of Mathematics and Computer Science, 220 N Grand Boulevard, Saint Louis, MO 63103, and **Ashish K Srivastava** (asrivas3@slu.edu), Saint Louis University, Dept. Of Mathematics and Computer Science, 220 N Grand Boulevard, Saint Louis, MO 63103. *Decomposing Elements of a Right Self Injective Ring.*

It was proved independently by both Wolfson [An ideal theoretic characterization of the ring of all linear transformations, Amer. J. Math. 75 (1953), 358-386] and Zelinsky [Every Linear Transformation is Sum of Nonsingular Ones, Proc. Amer. Math. Soc. 5 (1954), 627-630] that every linear transformation of a vector space V over a division ring D is the sum of two invertible linear transformations except when V is one-dimensional over $\mathbb{Z}_2$. This was extended by Khurana and Srivastava [Right self-injective rings in which each element is sum of two units, J. Algebra and its Appl., Vol. 6, No. 2 (2007), 281-286] who proved that every element of a right self-injective ring R is the sum of two units if and only if R has no factor ring isomorphic to $\mathbb{Z}_2$. In this paper we prove that if R is a right self-injective ring, then for each element $a \in R$ there exists a unit $u \in R$ such that both $a + u$ and $a - u$ are units if and only if R has no factor ring isomorphic to $\mathbb{Z}_2$ or $\mathbb{Z}_3$. (Received August 27, 2013)

1094-16-394 **Miodrag C Iovanov*** (miodrag-iovanov@uiowa.edu). *Complete path algebras and the infinite dimensional pure semisimplicity conjecture.*

The category of locally finite modules over an arbitrary algebra can be thought of as the inf inite dimensional generalization of the category of modules over a f nite dimensional one. We thus consider the following (in finite) version of the pure semisimplicity conjecture: if every locally nite left A-module over an arbitrary algebra A decomposes as a direct sum of indecomposable modules, does the same follow for every right locally nite A-module? We study algebras with the property that fi nite dimensional representations are serial, and show that a theory that parallels in good part the theory of in nite primary abelian groups can be developed. Using this, we find classes of counterexamples to the above in finite version of pure semisimplicity conjecture. Among these are the dense subalgebras of the complete path algebra of the half line quiver. Time permitting, we also present several other related properties of such complete algebras. (Received August 27, 2013)

18 ► Category theory; homological algebra

1094-18-192 **Furuzan Ozbek*** (furuzanozbek@uky.edu), **Pedro Guil Asensio** (paguil@um.es) and **Sergio Estrada** (sestrada@um.es). *Covering ideals of morphisms and module representations of the quiver* $\mathbb{A}_2$. Preliminary report.

The concepts of envelope and cover were introduced independently by Enochs and Auslander-Smalø for classes of modules. Since then the definition has been applied to different classes of categories. One of the recent application was introduced by Herzog, Fu, A. Guil and Torrecillas where the theory of covers and envelopes is extended to ideals. In this talk, we will show how identifying an ideal $\mathcal{I}$ with a certain class of objects in $\mathbb{A}_2$ can help us to obtain sufficient conditions for $\mathcal{I}$ to be a covering ideal. (Received August 28, 2013)

1094-18-212 **Denise Amanda Rangel*** (denise.rangel@mavs.uta.edu), 411 S. Nedderman Drive, Arlington, TX 76019. *Filtration of Totally Reflexive Modules.* Preliminary report.

Representation theory of Maximal Cohen-Macaulay modules over commutative local Gorenstein rings is well-developed. The analog of maximal Cohen- Macaulay modules over commutative local non-Gorenstein rings are called totally reflexive (TR) modules. In this case, the theory of their representation is very limited. What is known is that if there is one non-free TR module, then there are infinitely many non-isomorphic indecomposable ones. In this talk, we will discuss the background of totally reflexive modules as well as some preliminary representation theory results over commutative local non- Gorenstein rings. In particular, for certain rings we will introduce a subcategory of TR modules that have a saturated filtration by other TR modules. These turn out to be precisely the TR modules with an upper-triangular presentation matrix. (Received August 23, 2013)

1094-18-272 **Boris Tsygan*** (btsygan7@gmail.com), 2300 Sherman Avenue, Evanston, IL 60201. *Groupoids and microlocal methods in symplectic geometry.*

I will review the current state of microlocal methods in symplectic geometry, including Tamarkin's work on sheaf-theoretic microlocal categories and my work on oscillatory modules. (Received August 26, 2013)

1094-18-278 **Ilya Shapiro*** (ishapiro@uwindsor.ca), 401 Sunset Avenue, Windsor, Ontario N9B 3P4, Canada. *Bitorsors, gerbes, and duality.* Preliminary report.

We discuss a conceptual approach to a certain duality for gerbes on orbifolds, and its variants. We alternate between the languages of Lie groupoids and differentiable stacks. (Received August 26, 2013)

19 ► K-theory

1094-19-265 **Elizabeth Gillaspy*** (elizabeth.a.gillaspy@dartmouth.edu), Dartmouth College Mathematics Department, 27 N. Main St., Hanover, NH 03755. *K-theory and homotopies of 2-cocycles on groupoids.* Preliminary report.

The rotation algebras A_θ can be realized as twisted group C^*-algebras: $A_\theta = C^*(\mathbb{Z}, c_\theta)$, where

$$c_\theta((m,n),(j,k)) = e^{2\pi i\theta(nj)}.$$

Observe that the map $\theta \mapsto c_\theta((m,n),(j,k))$ is continuous for each fixed $(m,n),(j,k) \in \mathbb{Z}^2$. Moreover, all the rotation algebras have isomorphic K-theory groups.

In other words, the rotation algebras provide an example of a continuously varying family $\{\omega_t\}_{t\in[0,1]}$ of 2-cocycles on $\mathbb{Z}^2$ that gives rise to twisted group C^*-algebras with isomorphic K-theory.

This phenomenon is actually quite general: examples of groupoids for which a homotopy of cocycles induces an isomorphism on K-theory include symplectic vector bundles, transformation groups $G \ltimes X$ where G satisfies the Baum-Connes conjecture with coefficients and X is compact, and k-graph groupoids. Furthermore, there are no known counterexamples. In this talk, we will discuss some of the above-mentioned examples and our progress towards expanding the class of known examples to include Deaconu-Renault groupoids. (Received August 26, 2013)

1094-19-274 **Boris Tsygan***, 2300 Sherman Avenue, Evanston, IL. *Index theory and algebraic K-theory.* Preliminary report.

The Atiyah-Singer index theorem expresses the index of an elliptic differential operator as the integral over the cotangent bundle of a cohomology class depending only on the principal symbol. We will present a conjectural generalization of this theorem. It expresses the virtual space which is the difference of the kernel and the cokernel as the integral over the cotangent bundle of a cohomology class of the cotangent bundle with coefficients in a presheaf of spectra. In other words, the morphism associating to an elliptic complex its Euler characteristic can be extended to a morphism from the algebraic K theory spectrum of the category of elliptic complexes to the algebraic K theory spectrum K(C) of complex numbers, and we give a conjectural formula for it. This formula involves integration over the cotangent bundle of a K(C)-valued cohomology class. A more general statement gives a similar formula for the Euler characteristic of an elliptic pair. There is also a conjectural generalization along the same line of the index theorem for Toeplitz operators. These conjectures unite many known results including the Atiyah-Singer, higher index theorems of Carey -Pincus and Kaad-Nest, Beilinson's formula for the determinant line, etc. This is a joint work with Deepam Patel. (Received August 26, 2013)

20 ► Group theory and generalizations

1094-20-21 **Ronald Mark Solomon*** (solomon.1@osu.edu). *Recognizing abelian Sylow subgroups.*

Navarro and Tiep recently provided an elementary affirmative answer, for primes different from 3 and 5 to Brauer's question: Can abelian Sylow subgroups be detected from the character table of a finite group G? We report on the following extension of their work to cover these two primes.

Theorem. *Let G be a finite group and $p \in \{3,5\}$. Suppose that every p-element of G is p-central. Then*

$$O^{p'}(G/O_{p'}(G)) = S_1 \times \cdots \times S_r \times H$$

where H has abelian Sylow p-subgroups, $r \geq 0$, and S_i is a nonabelian simple group with $S_i \cong Th$ if $p = 5$; while, if $p = 3$, $S_i \cong Ru$ or $S_i \cong J_4$ or $S_i \cong {}^2F_4(q_i)$ with $q_i + 1$ divisible by 3 but not 9. (Received July 11, 2013)

1094-20-58 **Stephen D Smith*** (smiths@uic.edu), IL. *Yet another approach to the Alperin Weight Conjecture.* Preliminary report.

Alperin (1985) conjectured that the global count of p-modular irreducibles of G should be locally determined as the sum of the count of "weights" of p-local subgroups of G. Knörr and Robinson (1989) gave a formulation for a particular p-block B—now involving an *alternating* sum over blocks B_c for certain local subgroups G_c. The

resemblance of this alternating sum to an Euler characteristic then led to formulations in topological language; for example, by Linckelmann, Symonds, and Boltje.

One result of Knörr-Robinson can be interpreted as giving an analogue of Webb's decomposition of group cohomology $H^*(G)_p$; namely a decomposition of the G-conjugation *module* cohomology $H^n(G,B)_p$ for $n>0$, via terms $H^n(G_c,B_c)_p$, reducing the Alperin Conjecture to proving the decomposition at $n=0$. Indeed one can embed this in the framework of ample and sharp decompositions from the topological literature—notably the context of Bredon cohomology and higher limits of Grodal.

This viewpoint of reducing the conjecture to of $H^0(G,B)_p$ focuses attention on the "lower defect groups" of Brauer. Which motivates renewed efforts along that (much-studied and difficult) avenue toward the Conjecture. (Received August 06, 2013)

1094-20-59 **Stephen D Smith*** (smiths@uic.edu). *A Bredon cohomology approach to the blockwise Alperin Weight Conjecture.* Preliminary report.

Alperin (1985) conjectured a combinatorial formula for the number of p-modular irreducibles of a group G. Later Knörr and Robinson (1989) gave a formulation for a particular p-block B of G; via an alternating sum over blocks B_c for certain local subgroups G_c. Viewing that sum as an Euler characteristic led various authors (Linckelmann, Symonds, Boltje...) to versions in the spirit of the topological literature on decompositions of group cohomology $H^*(G)_p$ (pioneered by Webb in the 1980s).

This talk considers an analogous possible decomposition of the G-conjugation *module* cohomology $H^n(G,B)_p$, via terms $H^n(G_c,B_c)_p$. Indeed a result of Knörr-Robinson implies the decomposition for $n>0$; reducing the Alperin Conjecture to proving the decomposition at $n=0$.

This approach also fits naturally into the context developed by Grodal: The B_c define a coefficient system $\mathcal{B}$; and the Bredon cohomology of $\mathcal{B}$ should "approximate" that of B. In particular the higher limits $\lim^*_c H^n(G_c,B_c)$ afford the n-th row of the E^2-page of a natural spectral sequence; and one can investigate possible vanishing of these limits, in the spirit of the "sharpness" property for decompositions. (Received August 06, 2013)

1094-20-73 **Attila Maroti**, Realtanoda UTCA 13-15, Budapest H-1053, Hungary, and **Hung Ngoc Nguyen*** (hungnguyen@uakron.edu), Department of Mathematics, The University of Akron, Akron, OH 44325. *On the number of conjugacy classes of π-elements in finite groups.*

The probability that two elements of a finite group G commute is $d(G):=k(G)/|G|$ where $k(G)$ is the number of conjugacy classes of G. This has been a topic of interest for many years, dating back to the works by Gustafson in the seventies and later by Lescot in the nineties. Let π be a set of primes and consider the π-local analogue $d_\pi(G):=k_\pi(G)/|G|_\pi$ where $k_\pi(G)$ is the number of conjugacy classes of π-elements in G. Since $d(G)$ encodes a lot of structural information of G, it is expected that $d_\pi(G)$ also provides some information on the π-local structure of G.

We prove that if $d_\pi(G)>5/8$ then G possesses an abelian Hall π-subgroup which meets every conjugacy class of π-elements of G – a result that can be viewed as a local version and generalization of Gustafson's result stating that if $d(G)>5/8$ then G is abelian. We also prove that there is no possible value of $d_\pi(G)$ in $(2/3,1)\cup(1,\infty)$ and describe the structure of finite groups with $d_\pi(G)=1$ or $2/3$. This is a joint work with Attila Maroti. (Received August 10, 2013)

1094-20-152 **Matthew JK Gelvin*** (mgelvin@gmail.com), 278 Court Street, #207, Middletown, MA 06459, and **Sune P Reeh** (spr@math.ku.dk). *Minimal characteristic bisets of saturated fusion systems.*

Let S be a finite p-group and $\mathcal{F}$ a saturated fusion system on S. A characteristic biset Ω for $\mathcal{F}$ is an (S,S)-biset that abstracts the left and right multiplication of S on an ambient group that induces $\mathcal{F}$. It is known that the biset determines the fusion system, but not conversely. Recent work has shown that there is always a unique *minimal* characteristic biset $\Omega_\mathcal{F}$.

In this talk we will discuss several structure theorems for $\Omega_\mathcal{F}$, leading to the result that a centric linking system $\mathcal{L}$ associated to $\mathcal{F}$ is the p-centric part of $\Omega_\mathcal{F}$. $\Omega_\mathcal{F}$ contains less and more data than $\mathcal{L}$: Less in that we do not have a partial multiplication; more in that even the non-$\mathcal{F}$-centric subgroups of S are seen. We will also discuss normalizers of subgroups $P\leq S$ in $\Omega_\mathcal{F}$ and the open conjecture that the normalizer biset is in fact the minimal characteristic biset for the normalizer subsystem: $N_{\Omega_\mathcal{F}}(P)=\Omega_{N_\mathcal{F}(P)}$. These results show a close connection between minimal characteristic bisets and p-local finite groups. (Received August 21, 2013)

1094-20-158 **Bhama Srinivasan*** (srinivas@uic.edu), Department of Mathematics, m/c 249, University of Illinois at Chicago, 851 S.Morgan St, Chicago, IL 60607. *Decomposition matrices of finite general linear groups.* Preliminary report.

An important and difficult problem in the modular representation theory of finite groups is to determine the decomposition matrices. In the case of the representations of the finite general linear group $GL(n,q)$ in non-defining characteristic, there are connections with Lie theory, in particular with the action of an affine Lie algebra $\widehat{sl_e}$ and of a Heisenberg algebra H_e on a Fock space with basis indexed by partitions of all non-negative n. We describe these connections in this talk. (Received August 21, 2013)

1094-20-204 **Matthew D Welz*** (mwelz@uwsp.edu). 2-*Fusion Systems with Standard Components of type $PSL_2(q)$ or $SL_2(q)$.*

We discuss problems in the area of fusion systems which are designed to mimic, simplify, and generalize parts of the Classification of Finite Simple Groups. In the Classification, the simple groups are split between those of *characteristic 2-type* and those of *component type* (which, save a few exceptions, posses a *standard* component). Aschbacher recently laid out a major program of research: work toward a classification of fusion systems of "component type" in order to establish a new proof of the Classification for groups of component type. In this talk we consider two cases: where a 2-fusion system contains subgroups and fusion maps that arise in the Classification with standard components of type $SL_2(q)$ and $PSL_2(q)$. (Received August 23, 2013)

1094-20-233 **Silvia E Onofrei*** (onofrei@math.ohio-state.edu), 100 Math Tower, 231 West 18th Ave, Columbus, OH 43210. *Saturated fusion systems with parabolic families.*

Let G be group, a finite p-subgroup S of G is a Sylow p-subgroup if every finite p-subgroup of G is conjugate to a subgroup of S. In this talk, I examine the relations between the fusion system over S which is given by conjugation in G and a certain chamber system $\mathcal{C}$, on which G acts chamber transitively with chamber stabilizer $N_G(S)$.

Next, I introduce the notion of a fusion system with a parabolic family and I show that a chamber system can be associated to such a fusion system. I determine some conditions the chamber system has to fulfill in order to assure the saturation of the underlying fusion system.

An application to fusion systems with parabolic families of classical type will be given. (Received August 25, 2013)

1094-20-235 **Spencer Dowdall**, University of Illinois, Urbana, IL 61801, **Ilya Kapovich**, University of Illinois, Urbana, IL 61801, and **Christopher J Leininger*** (clein@math.uiuc.edu), University of Illinois, Urbana, IL 61801. *Dynamics on free-by-cyclic groups.*

The work of Thurston and Fried on fibered hyperbolic 3-manifolds provides a framework for studying all the ways in which such a 3-manifold fibers over the circle, resulting in interesting geometric, topological and dynamical connections between the monodromies for such fibrations. For a finitely generated free-by-cyclic group G, we construct an object analogous to a hyperbolic 3-manifold and provide an analogous framework in which we can study the monodromies for different homomorphisms of G to Z. This talk will consist of an explanation of this construction for a single example, illustrating the various conclusions we may draw. This is joint work with Spencer Dowdall and Ilya Kapovich. (Received August 25, 2013)

1094-20-244 **Michael Geline*** (geline@math.niu.edu), Watson Hall, DeKalb, IL 60115, and **Nadia Mazza**, , United Kingdom. *Almost split sequences for Knörr lattices.* Preliminary report.

Auslander and Reiten, some time ago, showed that the indecomposable modules for a finite dimensional algebra are naturally organized into a graph using the data of certain short exact sequences known as almost split sequences. Such sequences also exist for indecomposable RG-lattices where R is a p-adic ring, and G is a finite group. We show that under mild conditions, the almost split sequence for a Knörr RG-lattice has an indecomposable middle term. This is joint work with Nadia Mazza. (Received August 25, 2013)

1094-20-254 **Alex Gonzalez*** (agondem@mat.uab.cat). *Homotopy fixed points of p-local finite groups and fixed points of localities.*

Given discrete groups Q, G and an action of Q on G, the homotopy fixed point set of the classifying space BG by the action of Q can easily be described in terms of the group data, basically as a disjoint union of fixed point subgroups of G (which will be quickly described in the talk).

In this talk we consider a similar situation, where G is replaced by a p-local finite group, Q is assumed to be a p-group, and the action is assumed to be via isotypical equivalences. Using only the categorical approach of p-local finite groups, one can deduce that the resulting homotopy fixed point set in this situation is a disjoint union of classifying spaces of p-local finite groups, but it is not clear how this relates to the original data.

I will explain how, combining the above with the language of localities developed by A. Chermak, we can describe homotopy fixed point sets of p-local finite groups by means of the original p-local group data, as a disjoint union of fixed point partial subgroups of the locality associated to the given p-local finite group. (Received August 26, 2013)

1094-20-273 **Nathan E Bloomfield*** (nathan.e.bloomfield@gmail.com). *On partial algebras of full difunctional relations.*

The set $\mathsf{Dif}(X)$ of all full and difunctional relations on a set X essentially consists of the bijections among the quotients of X, and so generalizes the symmetric group on X and dualizes the symmetric inverse semigroup on X. However, $\mathsf{Dif}(X)$ is only a partial algebra under relation composition. We exhibit an axiomatic class of partial algebras to which $\mathsf{Dif}(X)$ belongs and having the Cayley-like property that every instance M of this class embeds weakly in some $\mathsf{Dif}(X_M)$. This class of algebras simultaneously generalizes the classes of inverse semigroups, groupoids, and partially ordered sets under meet. (Received August 26, 2013)

1094-20-279 **Robert Boltje*** (boltje@ucsc.edu) and **Susanne Danz**. *The Ghost Algebra of the Double Burnside Ring.*

The double Burnside Ring $B(G,G)$ of a finite group G is embedded via the additive mark homomorphism (counting fixed points with respect to subgroups of $G \times G$) into the vector space over the rational numbers with basis consisting of the subgroups of $G \times G$. We introduce a natural multiplication on this vector space compatible with the multiplication on $B(G,G)$. This approach has applications to modular representation theory (see Philipp Perepelitsky's talk), fusion systems, and biset functors. (Received August 26, 2013)

1094-20-280 **John Maginnis*** (maginnis@math.ksu.edu) and **Silvia Onofrei**. *Fixed Point Sets and Lefschetz Modules for Subgroup Complexes.*

If a group acts on a finite simplicial complex, its virtual Lefschetz module is the alternating sum of the chain groups. A collection of subgroups, closed under conjugation, yields such a complex (the nerve, or flag complex). Under certain group theoretic hypotheses, a theorem about fixed point sets is proven, leading to information on the vertices and defect groups for the nonprojective summands of the reduced Lefschetz module. (Received August 26, 2013)

1094-20-288 **Rebecca R Winarski***, rwinarski@math.gatech.edu. *Symmetries of Covering Spaces.*

A general problem is to understand all (injective) homomorphisms between (finite index subgroups of) mapping class groups of surfaces. Birman and Hilden proved that if $S \to X$ is a regular branched covering space of surfaces, there is an embedding of the subgroup of the mapping class group of X consisting of mapping classes that have representatives that lift to S in the mapping class group of S modulo the group of deck transformations. This relationship does not always hold for irregular branched covers. We give a necessary condition and a sufficient condition for when such an embedding exists. We also give new explicit examples that satisfy the necessary condition and examples that do not satisfy the sufficient condition. (Received August 26, 2013)

1094-20-321 **Philipp Perepelitsky*** (pperepel@ucsc.edu). *p-permutation equivalences between blocks of finite groups.*

In this talk we describe joint work with Robert Boltje. Let F be an algebraically closed field of positive characteristic p. Let G and H be finite groups. Let A be a block of FG and let B be a block of FH. A *p-permutation equivalence* between B and A is an element γ in the group of (A,B)-p-permutation bimodules with twisted diagonal vertices such that $\gamma \cdot_H \gamma^\circ = [A]$ and $\gamma^\circ \cdot_G \gamma = [B]$. A p-permutation equivalence lies between a splendid Rickard equivalence and an isotypy.

We introduce the notion of a γ-Brauer pair, which generalizes the notion of a Brauer pair for a p-block of a finite group. The γ-Brauer pairs satisfy an appropriate Sylow theorem. Furthermore, each maximal γ-Brauer pair identifies the defect groups, fusion systems and Külshammer-Puig classes of A and B. Additionally, the Brauer construction applied to γ induces a p-permutation equivalence at the local level, and a Morita equivalence at the level of the defect groups of A and B. (Received August 27, 2013)

1094-20-346 **Andrew Chermak*** (chermak@math.ksu.edu). *Gluing Problems.*

The existence and uniqueness of a linking system for a given saturated fusion system can be viewed as a "gluing problem". Also, there is a gluing problem for 2-cocycles defined locally and "compatibly" on a saturated fusion system, and which, if solved, yields a reformulation (due to Linkelmann) of the Alperin weight conjecture. We present progress towards a solution of the second of these gluing problems, based on the solution of the first. The work is joint with Jesper Grodal and Ergun Yalcin. (Received August 27, 2013)

1094-20-348 **Amanda Alayne Schaeffer Fry*** (mandi@math.msu.edu), Department of Mathematics, Michigan State University, East Lansing, MI 48824. *Odd Characters and Self-Normalizing Sylow 2-Subgroups.* Preliminary report.

Let G be a a finite group, p a prime, and P a Sylow p-subgroup of G. A recent refinement, due to G. Navarro, of the McKay conjecture suggests that there should exist a bijection between irreducible characters of p'-degree of G and irreducible characters of p'-degree of $N_G(P)$ which commutes with certain Galois automorphisms. This Galois automorphism refinement of the McKay conjecture has several interesting consequences. I will discuss my progress on proving one of these consequences, namely a way to read off from the character table of G whether a Sylow 2-subgroup of G is self-normalizing. (Received August 27, 2013)

1094-20-357 **Adam Glesser*** (adamglesser@gmail.com). *Saturated fusion systems over 2-groups of 2-rank 2.*

The study of fusion systems, as a bridge between group theory, block theory, and algebraic topology, and as a new approach to the classification of finite simple groups, is currently incredibly active. In this talk, we discuss the current state of the classification of saturated fusion systems on 2-groups of 2-rank 2. (Received August 27, 2013)

1094-20-359 **Peter Webb*** (webb@math.umn.edu), School of Mathematics, University of Minnesota, Minneapolis, MN 55057. *Hecke algebras that are Iwanaga-Gorenstein.* Preliminary report.

In work with Serge Bouc and Radu Stancu we consider representations of the Hecke algebra which is the endomorphism ring of the direct sum of all (transitive) permutation modules for a finite group. These are equivalent to the representations of the Hecke category which has the permutation modules as its objects. By a theorem of Yoshida they are also equivalent to the cohomological Mackey functors on the group. Over a field of characteristic p we show that projective representations all have finite injective dimension if and only if Sylow p-subgroups are cyclic, or $p = 2$ and Sylow 2-subgroups are dihedral. (Received August 27, 2013)

1094-20-384 **Calder Daenzer*** (daenzer@math.psu.edu). *Geometric T-Dualization and Uniqueness.* Preliminary report.

I will describe how abelian principal bundles and abelian gerbes can be embedded in bundles of Picard groupoids. I will then describe a notion of Pontryagin duality for such bundles. Using this machinery, I will present a new construction of T-duality, and show how it is related to the Mathai-Rosenberg C*-algebraic construction. A central (and surprising) benefit of this method is that there are natural constraints imposed on the dualization procedure, which result in unique T-duals. Another benefit of this method is that it applies not only to principal torus bundles, but to affine torus bundles as well. (Received August 27, 2013)

22 ► Topological groups, Lie groups

1094-22-105 **carla farsi***, carla.farsi@colorado.edu, and **markus pflaum** and **christopher seaton**. *Differentiable groupoids and Morita Equivalence.* Preliminary report.

Let G be a differentiable groupoid. This in particular means that the space of units and the space of maps are differentiable spaces and the groupoid maps are differentiable maps (in the sense of Spalleck/Mostow). We will first detail some general properties of differentiable groupoids, and then, motivated by the example of the inertia groupoid of a proper Lie groupoid, we will study their Morita equivalence classes. (Received August 15, 2013)

1094-22-165 **Carla Farsi** (farsi@euclid.colorado.edu), Department of Mathematics, University of Colorado at Boulder, Campus Box 395, Boulder, CO 80309, **Markus Pflaum** (markus.pflaum@colorado.edu), Department of Mathematics, University of Colorado at Boulder, Campus Box 395, Boulder, TN 80309, and **Christopher Seaton*** (seatonc@rhodes.edu), Mathematics and Computer Science, 2000 N. Parkway, Memphis, TN 38112. *The inertia space of a proper Lie groupoid as a stratified differentiable space.* Preliminary report.

Let G be a proper Lie groupoid. If G is a foliation or étale groupoid, the the orbit space is an orbifold. In the study of the geometry and topology of orbifolds, an object called the inertia orbifold has played a major role. The inertia orbifold is presented by the Lie groupoid $G \ltimes \Lambda G$ where ΛG is the space of loops in G.

If G is an arbitrary proper Lie groupoid, then ΛG is no longer a smooth manifold so that the inertia groupoid $G \ltimes \Lambda G$ is no longer a Lie groupoid. Rather, the orbit and arrow spaces of $G \ltimes \Lambda G$ inherit the structure of a differentiable space (in the sense of Spallek). In this talk, we will discuss the structure of the object and orbit

spaces of the inertia groupoid as differentiable stratified spaces and the behavior of these structures with respect to Morita equivalence. (Received August 21, 2013)

1094-22-175 **Kwangho Choiy*** (kwangho.choiy@okstate.edu), Department of Mathematics, 506 MSCS, Oklahoma State University, Stillwater, OK 74078-1058, and **David Goldberg**. *Invariance of R-groups between p-adic inner forms of quasi-split classical groups.*

R-groups describe the structure of parabolic induction and the elliptic spectrum for a p-adic group in a combinatorial manner. In this talk, we will discuss R-groups for non quasi-split classical groups, which are p-adic inner forms of $SO(2n+1)$, $Sp(2n)$, $SO(2n)$, and transfer the results of R. Herb (1993) and D. Goldberg (1994) for the split classical groups. This is joint work with David Goldberg. (Received August 22, 2013)

1094-22-195 **Chris Jantzen*** (jantzenc@ecu.edu), Department of Mathematics, East Carolina University, Greenville, NC 28590. *Duality for classical p-adic groups.*

This talk will discuss the problem of calculating the dual (in the sense of Aubert and Schneider-Stuhler) of an irreducible representation of a classical p-adic group. (Received August 23, 2013)

1094-22-220 **Rui Loja Fernandes*** (ruiloja@illinois.edu). *Riemannian structures on Lie groupoids.*

In this talk I will discuss the notion of a multiplicative Riemannian structure on a Lie groupoid and I will explain how it can be applied to give a simple proof of local linearization of a groupoid around a leaf. This new notion differs from a certain notion of Riemannian groupoid that one can find in the literature. (Received August 24, 2013)

1094-22-241 **Daniel Szpruch*** (dszpruch@math.purdue.edu). *On a local correspondence between similitude metalectic group and similitude orthogonal groups.*

In a recent paper, Gan and Savin established a bijection between the set of genuine representations of the metaplectic group and the representations of two orthogonal groups. The authors used this bijection to prove the Local Langlands conjecture for the metaplectic group. In this talk we shall explain how to extend this bijection to a correspondence between the similitude metaplectic group and similitude orthogonal groups. The main ingredients of this extension are the theta correspondence for similitudes constructed by Roberts and a surprising relation between the representation theory of the similitude metaplectic group and the representation theory of the metaplectic group. (Received August 25, 2013)

1094-22-258 **Aaron Wood*** (woodad@missouri.edu), 202 Mathematical Sciences Building, University of Missouri, Columbia, MO 65211. *Metaplectic formal degree in the wild case.*

In this talk, a Hecke algebra of the two-fold central extension of the symplectic group $\mathrm{Sp}_{2n}(\mathbb{Q}_2)$ is described and the formal degree of the Steinberg representation of this Hecke algebra is computed. In particular, the formal degree is shown to be equal to that of the trivial representation of a split orthogonal group of type B_n. (Received August 26, 2013)

1094-22-366 **Mahir Bilen Can*** (mcan@tulane.edu), 6823 St. Charles Ave., Department of Mathematics, Tulane University, New Orleans, LA 70118, and **Roger Howe**. *Some results on the branching problem for g2.* Preliminary report.

In this talk, using some combinatorial techniques and building on the 1995 Ph.D. thesis of late Yui Kwan Wang, we report on our latest progress on the branching of representations of the exceptional Lie algebra g2. This is a joint work with Roger Howe. (Received August 27, 2013)

1094-22-388 **Stephen DeBacker*** (smdbackr@umich.edu) and **Jeff Adler**. *Tori in Reductive p-adic Groups.*

There are a variety of ways to parameterize tori in a reductive p-adic group. We shall present an explicit approach that involves Bruhat-Tits theory. The results are not complete; however, as they stand, they do provide a different way to understand the set of geometric strongly regular semisimple elements that contain a rational element. (Received August 27, 2013)

28 ► Measure and integration

1094-28-70 **Almut Burchard*** (almut@math.toronto.edu), University of Toronto, Dept. of Mathematics, Bahen Center, Room 6290, 40 St. George Street, Toronto, Ontario M5S 2E4, Canada. *Perimeter under multiple Steiner symmetrizations.*

Steiner symmetrization along n linearly independent directions in transforms every compact subset of $\mathbb{R}^n$ into a set of finite perimeter. (Joint work with Gregory R. Chambers.) (Received August 09, 2013)

1094-28-308 **Zoltan M Balogh** and **Piotr Hajlasz*** (hajlasz@pitt.edu), University of Pittsburgh, Department of Mathematics, 301 Thackeray Hall, Pittsburgh, PA 15260, and **Kevin Wildrick**. *Weak contact equations for mappings into Heisenberg groups.*

Let $k > n$ be positive integers. We consider mappings from a subset of k-dimensional Euclidean space R^k to the Heisenberg group H^n with a variety of metric properties, each of which imply that the mapping in question satisfies some weak form of the contact equation arising from the sub-Riemannian structure of the Heisenberg group. We illustrate a new geometric technique that shows directly how the weak contact equation greatly restricts the behavior of the mappings. In particular, we provide a new and elementary proof of the fact that the Heisenberg group H^n is purely k-unrectifiable. We also prove that for an open set U in R^k, the rank of the weak derivative of a weakly contact mapping in the Sobolev space $W^{1,1}_{loc}(U; R^{2n+1})$ is bounded by n almost everywhere, answering a question of Magnani. Finally we prove that if a mapping from U to H^n is s-Hölder continuous, $s > 1/2$, and locally Lipschitz when considered as a mapping into R^{2n+1}, then the mapping cannot be injective. This result is related to a conjecture of Gromov. (Received August 26, 2013)

1094-28-338 **Alfred M. Dahma*** (alfy@iup.edu) and **Christopher J. Lennard** (lennard@pitt.edu). *The spaces L_{-p} for $0 < p < \infty$.*

In this paper we extend the classical definition of L_p-spaces to include values of $p < 0$. If (Ω, Σ, μ) is a finite, non-atomic measure space, μ a positive measure, then we denote by $M(\mu)$ the space of equivalence classes of Σ-measurable functions. For all $p > 0$, $L_{-p}(\mu)$ is the set $M(\mu)$ together with a complete, translation invariant metric, d_{-p}, defined using the decreasing rearrangement of functions $f \in M(\mu)$. Defined as such, the inclusion $L_q(\mu) \subseteq L_p(\mu)$ extends to all $p, q \in \mathbb{R}$, $p < q$. Furthermore, $L_{-p}(\mu)$ can be equipped with an F-norm defined by $\|f\|_{-p} = d_{-p}(f, 0)$. In summary, for every $p > 0$, $(L_{-p}, \|\cdot\|_{-p})$ is an F-space. In contrast, the sets L_r for negative r defined in (for example) the text of DiBenedetto, are not even vector spaces. (Received August 27, 2013)

30 ► Functions of a complex variable

1094-30-101 **Anders Björn**, **Jana Björn**, **James T. Gill*** (jgill5@slu.edu) and **Nageswari Shanmugalingam**. *Geometric analysis on Cantor sets and trees.*

Using uniformization, Cantor type sets can be regarded as boundaries of rooted trees. In this setting, we show that the trace of a first-order Sobolev space on the boundary of a regular rooted tree is exactly a Besov space with an explicit smoothness exponent. Further, we study quasisymmetries between the boundaries of two trees, and show that they have rough quasiisometric extensions to the tree. We also show the converse. (Received August 14, 2013)

1094-30-196 **Andrew Lorent*** (lorentaw@uc.edu), 4109 French Hall, Cincinnati, OH 45219. *A generalized Stoilow decomposition for pairs of mappings of integrable dilatation.*

One of the consequences of the classic Liouville theorem is that given a pair of invertible C^1 functions whose symmetric parts of gradient agree; one is related to another by a rotation. The question of what is the minimal hypothesis for which this is true was asked by Ciallet and Mardare. This was also asked by Stefan Muller with a view developing a generalization of Friesecke-James-Muller rigidity estimate. This question is actually a special case of the following question: what is the most general Stoilow decomposition for pairs of functions? If we allow non invertible functions the answer turns out to be functions of integrable dilatation. We will describe this theorem and its corollaries, sketch the connections these questions have to theories of elasticity and describe some future directions. (Received August 23, 2013)

1094-30-199 **Mario Bonk**, **Juha Heinonen** and **Pietro Poggi-Corradini***, Department of Mathematics, Manhattan, KS 66506. *Singularities for the inverse of a quasiregular mapping.* Preliminary report.

We recall the classical notion of singularities for the inverse of a meromorphic function in the complex plane, and describe three known results: Heins's Theorem on direct singularities, the Denjoy-Carleman-Ahlfors Theorem on asymptotic values, and the Bergweiler-Eremenko Theorem on critical points and indirect singularities. We then discuss generalizations of these results to the context of quasiregular mappings in higher-dimensional Euclidean space. The most interesting aspect being the several ways one might prove a "localized" version of the Rickman-Picard Theorem. (Received August 23, 2013)

1094-30-215 **Matthew Chasse*** (chasse@kth.se) and **George Csordas**. *Discrete analogues of the Laguerre inequalities and a conjecture of I. Krasikov.*

A conjecture of I. Krasikov is proved. Several discrete analogues of classical polynomial inequalities are derived, along with results which allow extensions to a class of transcendental entire functions in the Laguerre-Pólya class. (Received August 24, 2013)

1094-30-250 **Nadia J Gal*** (nadiagal@math.miami.edu), University of Miami, 1365 Memorial Drive, Ungar 515, FL 33146, Coral Gables, FL 33146, and **RAENA KING**. *Projections on Some Vector Valued Function Spaces.* Preliminary report.

Let K be a separable Hilbert space and consider the space $S^p_{K(D)}$ of analytic K valued functions f on the disk D such that the derivative $f\prime$ belongs to the Hardy space $H^p(D,K)$, where $1 < p < \infty$. The norm on this space is $||f|| = |f(0)|_K + ||f\prime||_{H^p(D,K)}$. We consider the problem as to when the average of two isometries on $S^p_{K(D)}$ is a projection. This result is related to the generalized bi-circular projection problem .

This is joint work with Raena King. (Received August 25, 2013)

1094-30-333 **Vyron Sarantis Vellis*** (vellis1@illinois.edu), 1409 West Green Street, Urbana, IL 61801, and **Jang-Mei Wu**. *Quasisymmetric Spheres constructed over Quasidisks.*

In this talk we will provide some concrete examples of quasispheres and quasisymmetric spheres. We present two different constructions of surfaces in $\mathbb{R}^3$ constructed over planar quasidisks Ω. In the first construction, the surface is the graph of a function of $\text{dist}(\cdot, \partial\Omega)$. In the second, the level sets of the height of the surface are images of $\{r\mathbb{S}^1\}_{r<1}$ under a quasiconformal function that maps the unit disk onto Ω.

We examine the properties of the quasidisks and that of the height functions under which these surfaces are either quasispheres or quasisymmetric equivalent to $\mathbb{S}^2$. (Joint work with J.-M. Wu). (Received August 27, 2013)

1094-30-344 **Hrant Hakobyan*** (hakobyan@math.ksu.edu), 138 Cardwell Hall, Department of Mathematics, Manhattan, KS 66502. *Frequency of Dimension Distortion.*

We study the distortion of Hausdorff dimension of families of Ahlfors regular sets in a metric space under quasisymmetric mappings and mappings of finite distortion. The results are formulated in terms of Fuglede moduli of families of measures. (Received August 27, 2013)

1094-30-397 **Maria-Jose Martin-Gomez** (maria-jose.martin-gomez@uef.fi), Department of Physics and Mathematics, University of Eastern Finland, POB 111 (Yliopistokatu 2), 80101 Joensuu, Finland, **Eric T. Sawyer** (sawyer@mcmaster.ca), Dept. of Mathematics & Statistics, McMaster University, 1280 Main Street West, Hamilton, Ontario L8S 4K1, Canada, **Ignacio Uriarte-Tuero*** (ignacio@math.msu.edu), Department of Mathematics, Michigan State University, 619 Red Cedar Road, East Lansing, MI 48824, and **Dragan Vukotic** (dragan.vukotic@uam.es), Departamento de Matemáticas, Facultad de Ciencias, módulo 17, Universidad Autónoma de Madrid, 28049 Madrid, Spain. *The Krzyż conjecture revisited.* Preliminary report.

The conjecture of Krzyż, concerning the largest possible value of the Taylor coefficient a_n ($n \geq 1$) of a non-vanishing analytic function from the unit disk into the unit disk, has been open since 1968 in spite of the information available on the structure of extremal functions.

The purpose of this talk is to report on partial progress regarding the conjecture. We collect various conditions that the coefficients of an extremal function (and also the zeros of some polynomials associated with it) must satisfy and show that each one of these properties is equivalent to the conjecture itself.

This improves or complements a number of earlier findings by other authors and may hopefully provide several possible starting points for attempts at proving the conjecture. (Received August 27, 2013)

31 ► Potential theory

1094-31-144 **Igor E Pritsker*** (igor@math.okstate.edu), Department of Mathematics, Oklahoma State University, 401 MSCS, Stillwater, OK 74078. *Farthest distance function, potentials and polarization.*

We study the farthest–point distance function, which measures the distance from a point in $\mathbb{R}^d$ to a farthest point of the given compact set $E \subset \mathbb{R}^d, d \geq 2$. If $d = 2$ then the logarithm of this distance function is subharmonic, and equals the logarithmic potential of a unique probability measure with unbounded support. This fact has interesting applications to inequalities for norms of products of polynomials and sums of logarithmic potentials.

We give a new integral representation of an appropriate power of the farthest distance function as the Riesz potential of a unique unit measure, which is obtained via the Riesz decomposition theorem. The Newtonian case is included in our range of Riesz parameter. This result yields triangle inequalities for sums of Riesz potentials and estimates for Riesz polarization quantities. Furthermore, the representing measure of the farthest distance function has many interesting properties that reflect the geometry of the compact set E.

This is a joint work with E. B. Saff (Vanderbilt University) and W. Wise (Oklahoma State University). (Received August 20, 2013)

1094-31-314 **Vasilis Chousionis*** (vchous@illinois.edu), University of Illinois. *Removable sets for homogeneous linear PDE in Carnot groups.*

Let $\mathcal{L}$ be a homogeneous left invariant differential operator on a Carnot group. Assume that both $\mathcal{L}$ and its transpose are hypoelliptic. We study the removable sets for $\mathcal{L}$-solutions. We give precise conditions in terms of the Carnot–Carathéodory Hausdorff dimension for the removability for $\mathcal{L}$-solutions under several auxiliary integrability or regularity hypotheses. One of the main ingredients in our proof is the use of novel local self similar tilings in Carnot groups. Furthermore in the case when $\mathcal{L}$ is the sub-Laplacian we derive the critical dimension for removable sets for Lipschitz $\mathcal{L}$-harmonic functions. Finally we will discuss how the study of homogeneous singular integrals on lower dimensional subsets of a Carnot group is related to removable sets with critical dimension. Based on joint works with J. Tyson and P. Mattila. (Received August 26, 2013)

33 ► Special functions

1094-33-111 **Susanna Spektor*** (sanaspek@gmail.com), University of Alberta, Edmonton, Alberta T6G2G1, Canada. *AN ASYMPTOTICALLY SHARPFORM OF BALL'S INTEGRAL INEQUALITY.* Preliminary report.

My talk is devoted to Ball's integral inequality. First, I outline the proof of the inequality via spline functions. Then, I provide a method for computing all terms in the asymptotic expansion of the integral in the Ball's inequality. Also, I indicate how to derive an asymptotically sharp form of a generalized Ball's integral inequality. (Received August 27, 2013)

34 ► Ordinary differential equations

1094-34-72 **Hikmet Koyunbakan*** (hkoyunbakan@gmail.com), 400 West 12 Street, Rolla, MO 65401. *Inverse Nodal Problem for P-Laplacian energy-dependent Sturm-Liouville Operator.*

In this study, we obtain some asymptotic formulas and reconstructon formula for P-Laplacian energy-dependent Sturm-Liouville Operator. Results obtained in this paper are more general then the classical p-Laplacian sturm Liouville problem. (Received August 10, 2013)

1094-34-82 **Hulin Wu*** (hulin_wu@urmc.rochester.edu), 601 Elmwood Ave., Box 630, Rochester, NY 14642. *Multi-Scale Modeling of Immune Responses to Viral Infections: Mathematical and Statistical Challenges.*

Many systems in engineering and physics such as a rocket system can be represented by differential equations, which can be derived from well-established physics laws and theories. However, currently no laws or theories exist to deduce exact quantitative relationships and interactions among the elements in a biological system. It is unclear whether the biological systems follow a mathematical representation such as differential equations, similar to that for a man-made physics or engineering system. Fortunately, recent advances in cutting-edge biomedical technologies allow us to generate intensive high-throughput data to gain insights into biological systems. It is badly needed to develop mathematical models and statistical methods to test whether a biological system

follows a mathematical representation based on experimental data. In this talk, I will present our recent work in developing statistical methods to identify high-dimensional ordinary differential equation (HD-ODE) models and solve the associated inverse problems for HD-ODE models in modeling immune responses to influenza infection. The time course high-throughput data from both mice and human experiments will be used to illustrate our methodologies. (Received August 12, 2013)

1094-34-113 **Jacob J Weiss*** (weissjj@unk.edu), 905 W. 25th St., Founders Hall 2040, Kearney, NE 68849. *Positive Solutions to a Second Order Dynamic Equation.*

We will establish some criteria for the existence of multiple positive solutions for certain two point boundary value problems for the dynamic equation

$$-u^{\Delta\Delta} = f(t, u^{\sigma})$$

on a time scale $\mathbb{T}$. (Received August 16, 2013)

1094-34-134 **Yeter Sahiner*** (ysahiner@hacettepe.edu.tr). *oscillation of second order neutral mixed type dynamic equations.*

We present some sufficient conditions for neutral mixed type dynamic equations. Some known oscillation criteria for first order dynamic equations with delay are used . (Received August 19, 2013)

1094-34-174 **Ashrafur Rahman*** (srahma33@uwo.ca), Room 275A, Middlesex College, 1151 Richmond Street, London, Ontario N6A 5B7, Canada, and **Naveen K. Vaidya** and **Xingfu Zou**. *Impact of Tenofovir Gel as PrEP on HIV Infection: A Mathematical Model.*

Pre-exposure prophylaxis (PrEP) has been considered one of the promising interventions for HIV infection as experiments on various groups and sites have reported significant effectiveness of PrEP. This study evaluates the effectiveness of Tenofovir gel, one of the widely used PrEPs for women, through a mathematical model. Our model has excellent agreement with the experimental data on the use of Tenofovir gel as PrEP in South African women. Using our model, we estimate both male-to-female and female-to-male transmission rates with and without Tenofovir gel protection. Through these estimates we demonstrate that the use of Tenofovir gel as PrEP can significantly reduce the reproduction number, new infections, and HIV prevalence in South Africa. Our results further show that the effectiveness of Tenofovir gel largely depends on the level of adherence to the gel and the proportion of women under gel coverage. Even though Tenofovir gel alone may not be able to eradicate the disease as indicated by our estimates of the reproduction numbers, together with other interventions such as condom use, it can serve as a strong weapon to fight against HIV epidemics. (Received August 22, 2013)

1094-34-255 **Bonita A. Lawrence*** (lawrence@marshall.edu), Marshall University, Department of Mathematics, One John Marshall Drive, Huntington, WV 25755, and **Kayode D. Olumoyin** and **Molly K. Peterson**. *Solutions of dynamic equations on a sequence of converging time scales.*

The broad focus of our study is the behavior of solutions of a sequence of first order dynamic equations defined on a sequence of time scales. In our initial study, we considered the first order dynamic equation,

$$u_n^{\Delta} = u_n,\ u_n(t_0) = u_{n,0}, t \in \mathbb{T}_n, \tag{1}$$

We are interested in the behavior of solutions as the sequence $\mathbb{T}_n$ converges to a compact interval $\mathbb{T}$. We will offer analytical as well as experimental results collected using the Marshall Differential Analyzer.

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(Received August 26, 2013)

35 ► Partial differential equations

1094-35-4 **Vladimir Sverak***, School of Mathematics, University of Minnesota, 206 Church Street S.E., Minneapolis, MN 55455. *PDE analysis of incompressible flows - old problems and recent develpments.*

Long-standing open questions about the Navier-Stokes and Euler equations include well-posedness, uniqueness, global existence, long-time behavior and stability. Although the best known problems remain unanswered, partial

progress on some of the old questions has been recently achieved by several research groups. We will discuss some of these developments. (Received August 28, 2013)

1094-35-26 **Murat Akman*** (murat.akman@uky.edu), Department of Mathematics, University of Kentucky, Lexington, KY 40506, and **John Lewis** and **Andrew Vogel**. *Hausdorff dimension of a certain measure.* Preliminary report.

In the first part of my talk I will discuss the Hausdorff dimension of a measure related to a positive weak solution of a certain partial differential equation in a simply connected domain. Our work generalizes work of Lewis and coauthors when the measure is $p-$harmonic and also for $p = 2$, the well known theorem of Makarov regarding the Hausdorff dimension of harmonic measure relative to a point in a simply connected domain.

In the second part of my talk I will present a recent result in the study of Hausdorff dimension of p-harmonic measure for $p \geq n$ when p-harmonic function is defined on an open subset of $\mathbb{R}^n$ and vanishing on a portion of boundary of this open set. This is a joint work with John Lewis and Adrew Vogel. (Received July 16, 2013)

1094-35-61 **Ali Akgul*** (aliakgul00727@gmail.com), Seyh Samil Mah. Emek Cad., Ergin 2 Ap. No:1, and **mustafa Inc** and **adem kilicman**. *New Method for Solving the One-Dimensional Sine–Gordon Equation.*

In this paper, we discuss a reproducing kernel method (RKM) for solving the sine–Gordon (SG) equation with initial and boundary conditions based on the reproducing kernel theory. Its exact solution is represented in the form of series in the reproducing kernel space. Some numerical examples have been studied to demonstrate the efficiency of the present method. The results obtained from the method are compared with the exact solutions and the earlier works. Results of numerical examples show that the presented method is very powerful. (Received August 13, 2013)

1094-35-95 **Richard S Laugesen*** (laugesen@illinois.edu) and **Bartlomiej A Siudeja**. *Sharp Estimates on the Magnetic Spectrum for Starlike Domains.*

We investigate sharp upper bounds on spectral functionals of the magnetic Laplacian (for a particle without spin), on convex and starlike plane domains. Our results cover the first eigenvalue, spectral zeta function, partition function, and more. The geometric normalization involves moment of inertia, area, and a natural log-L^2 measure of the roughness of the boundary. (Received August 13, 2013)

1094-35-115 **Juan J Manfredi*** (manfredi@pitt.edu), Department of Mathematics, University of PIttsburgh, Pittsburgh, PA 15215, and **Julio D Rossi** and **Stephanie J Somersille**. *An Obstacle Problem for Tug-of-war Games.*

We present an interpretation of the obstacle problem for the ∞-Laplacian using tug-of-war games. Given Lipschitz boundary data and obstacle, we prove existence and uniqueness of a super infinity-harmonic function constrained to lie above the obstacle and that it is infinity-harmonic when it is above the obstacle. Moreover, we show that this function is the limit of value functions of a game we call obstacle tug-of-war. (Received August 16, 2013)

1094-35-122 **Aghalaya S Vatsala*** (vatsala@louisiana.edu), Department of Mathematics, University of Louisiana at Lafayette, Lafayette, LA 70504, and **Donna Sue Stutson**. *Sub Hyperbolic Linear Partial Fractional Differential Equation in One Dimensional Space with Numerical Results.* Preliminary report.

Using the eigenfunction expansion method we obtain a representation form for the solution of the linear non homogenous sub hyperbolic Caputo fractional partial differential equation in one dimensional space. The solution obtained depends on the nonhomogeneous terms of the equation and the initial and boundary conditions. Here we consider the q^{th} order fractional differential equation in time variable for $1 < q < 2$. Results when $0 < q < 1$ can be obtained as a special case of the results obtained here. The software MAPLE 16 is used to graphically represent solutions to some linear non homogenous sub hyperbolic Caputo fractional partial differential equation in one dimensional space. (Received August 16, 2013)

1094-35-150 **Kazuo Yamazaki*** (kyamazaki@math.okstate.edu), 401 Mathematical Sciences Building, Department of Mathematics, Oklahoma State University, Stillwater, OK 74078. *Remarks on the global regularity of two-dimensional magnetohydrodynamics system with zero dissipation.*

In two dimension, it is well-known that the initial value problem of the Euler equation (invisicid Navier-Stokes equation) admits global regularity results. However, it remains unknown whether an analogous result may be obtained for the inviscid magnetohydrodynamics system or not.

Recently there has been much progress made toward this goal by various mathematicians considering different ranges of powers of the fractional Laplacians for its dissipation and diffusion terms. We discuss these results. Topics of discussion will also include logarithmically super-critical magnetohydrodynamics system, regularity criteria in case dimension is three as well as the stochastic case added by white noise. (Received August 20, 2013)

1094-35-173 **Toan T. Nguyen*** (nguyen@math.psu.edu), Department of Mathematics, Penn State University, University Park, State College, PA 16802. *Stability of boundary layers in the Navier-Stokes equations.*

I will discuss an overview of recent results on instability of boundary layers in the Navier-Stokes equations. We'll start from the linear to nonlinear instability of the Prandtl equations in Sobolev spaces. This includes joint work with David Gerard-Varet and Yan Guo. (Received August 22, 2013)

1094-35-176 **John Hunter** (hunter@math.ucdavis.edu), Department of Mathematics, One Shields Ave, Davis, CA 95616, **Mihaela Ifrim*** (mifrim@math.mcmaster.ca), Deparment of Mathematics and Statistics, 1280 Main Street West, McMaster University, Hamilton, Ontario L8S 4K1, Canada, and **Daniel Tataru** (tataru@math.berkeley.edu), Department of Mathematics, University of California, 970 Evans, Berkeley, CA 94720-3840. *Two dimensional water waves in holomorphic coordinates.*

This article is concerned with the infinite bottom water wave equation in two space dimensions. We consider this problem expressed in position-velocity potential holomorphic coordinates. Viewing this problem as a quasi-linear dispersive equation, we establish two results: (i) local well-posedness in Sobolev spaces, and (ii) almost global solutions for small localized data. Neither of these results are new; they have been recently obtained by Alazard-Burq-Zuily, respectively by Wu using different coordinates and methods. Instead our goal is improve the understanding of this problem by providing a single setting for both results, as well as new, somewhat simpler proofs.
(Received August 22, 2013)

1094-35-178 **Hongjie Dong*** (hongjie_dong@brown.edu). *Boundary regularity for the Navier-Stokes equations in high dimensions.*

we consider the incompressible Navier-Stokes equations in two cases: the 4D time-dependent case and the 6D stationary case. We prove ϵ-regularity criteria for suitable weak solutions up to the boundary. As an application, boundary partial regularity results are obtained. The proofs are based on a unified approach, and do not involve any compactness argument. (Received August 22, 2013)

1094-35-182 **Parimah Kazemi*** (kazemip@beloit.edu), Department of Mathematics, Beloit College, 800 College Street, Beloit, WI 53511. *Numerical methods for finding stationary states of the Gross-Pitaevskii equation.*

We present results for the numerical optimization of the Gross-Pitaevskii functional with rotation

$$E(u) = \int_D \frac{|\nabla u|^2}{2} + \frac{C_{trap}|u|^2}{2} + \frac{C_g|u|^4}{4} - \Omega L_z(u)$$

where L_z gives the third component of angular momentum. One seeks a minimum subject to the constraint $\int_D |u|^2 = 1$. Our numerical scheme involves time discretization of a dynamical system resulting from a gradient flow. We compare computational performance as well as stability of different schemes in consideration with varying physical parameters of the system such as rotation frequency. The Gross-Pitaevskii equation is used to model stationary states and time evolution for Bose-Einstein condensates, a gas of non interacting particles at very low temperatures in which the atoms in the condensate follow the same complex wave function. Our results our novel in the sense that we make successful use of operator preconditioning for nonlinear systems to improve computational performance. The preconditioner that we use incorporates physical parameters of the problem. (Received August 22, 2013)

1094-35-185 **Zhiwu Lin** and **Chongchun Zeng***, zengch@math.gatech.edu. *Unstable manifolds and nonlinear instability of Euler equations.*

We consider the nonlinear instability of a steady state v_0 of the Euler equation in an n-dim fixed bounded domain. When considered in H^s, $s > 1$, at the linear level, the stretching of the steady fluid trajectories may induce unstable essential spectrum which corresponds to linear instability at small spatial scales and the corresponding growth rate depends on the choice of the space H^s. More physically interesting linear instability relies on the unstable eigenvalues which correspond to large spatial scales. Much of the previous results obtaining the expected nonlinear instability in L^2 (the energy space, large spatial scale) were in 2-dim. In the case when the linearized

Euler equation at v_0 has an exponential dichotomy in center-stable and unstable (from eigenvalues) directions, we prove, in any dimensions, the existence of the unique local unstable/stable manifold of v_0, under certain conditions, and thus its nonlinear instability. Our approach is based on the observation that the Euler equation on a fixed domain is an ODE on an infinite dimensional manifold of volume preserving maps in function spaces. (Received August 22, 2013)

1094-35-229 **Zhiwu Lin*** (zlin@math.gatech.edu). *Invariant manifolds of Vlasov-Poisson system and density dependent Euler equation.* Preliminary report.

In this talk, we will discuss recent work to construct stable and unstable manifolds of Vlasov-Poisson near unstable homogeneous equilibria (with Chongchun Zeng). For the proof, we extend our approach for the incompressible Euler equation in several ways. As a corollary, we get the nonlinear instability in the macroscopic sense. Moreover, we allow the steady distribution function to be vanishing, which had been excluded in the prior nonlinear instability proof. We will also briefly describe ongoing work to construct invariant manifolds for density dependent Euler equations (with Zeng and Shvydkoy). (Received August 25, 2013)

1094-35-242 **Hao Jia***, jiaxx034@umn.edu, and **Vladimir Sverak**. *Large distance asymptotic for non-homogeneous steady Navier Stokes in higher dimensions.*

We study the large distance asymptotic of solutions to non-homogeneous steady Navier Stokes equation in higher dimensions, and show that the leading order is given by corresponding solution of Stokes equation. The same problem in dimension 3 is still open. Joint work with V.Sverak (Received August 25, 2013)

1094-35-259 **Gerard Misiołek***, Mathematics, University of Notre Dame, Notre Dame, IN 46556. *Some examples of ill-posedness in fluid dynamics.*

. (Received August 26, 2013)

1094-35-306 **Igor Kukavica**, **Walter M Rusin*** (walter.rusin@okstate.edu) and **Mohammed Ziane**. *Primitive equations with continues initial data.*

We address the well-posedness of the primitive equations of the ocean with continuous initial data. We show that the splitting of the initial data into a regular finite energy part and a small bounded part is preserved by the equations thus leading to existence and uniqueness of solutions. (Received August 26, 2013)

1094-35-341 **Jennifer Beichman***, beichman@math.wisc.edu. *Nonstandard Dispersive Estimates and Linearized Water Waves.* Preliminary report.

In this talk, I will presents recent results on the relationship between the decay of a solution to the linearized water wave problem and its initial data. Certain new decay bounds for a class of 1D dispersive equations (including the linearized water wave) display a surprising growth factor, which we show is sharp. A further exploration leads to a result relating singularities of the initial data at the origin in Fourier frequency to the regularity of solutions to these dispersive equations. (Received August 27, 2013)

1094-35-355 **Peng Feng*** (pfeng@fgcu.edu), 11501 FGCU Blvd. S., Fort Myers, FL 33965. *On a diffusive predator-prey model with nonlinear harvesting.*

In this talk, we study the dynamics of a diffusive Leslie-Gower model with a nonlinear harvesting term on the prey. We analyze the existence of positive equilibria and their dynamical behaviors. In particular, we consider the model with a weak harvesting term and find the conditions for the local and global asymptotic stability of the interior equilibrium. The global stability is established by considering a proper Lyapunov function. In contrast, the model with strong harvesting term has two interior equilibria and bi-stability may occur for this system. We also give the conditions of Turing instability and perform a series of numerical simulations and find that the model exhibits complex patterns. (Received August 27, 2013)

1094-35-361 **Steve Zelditch*** (zelditch@math.northwestern.edu), Department of Mathematics Northwestern Univer, Evanston, IL 60208. *Spectral theory and Grauert tubes.* Preliminary report.

This talk is about the application of Poisson kernels and analytic continuation to Grauert tubes of real analytic Riemannian manifolds to spectral problems of the Laplacian. (Received August 27, 2013)

1094-35-379 **Anne Bronzi*** (annebronzi@gmail.com) and **Roman Shvydkoy**. *On the blow-up scenario for the Euler equations.* Preliminary report.

In this talk we will survey some results regarding the possibility of a self-similar blow-up for the Euler equations and present some new exclusion results. Furthermore, we will present some preliminary studies on the fractal dimension of the energy measure, which roughly speaking is the limit of the measures on the space induced

by the velocity squared as time approaches the time of the singularity. We will explore the relation between the fractal dimension of the energy measure and the growth of the velocity as time approaches the time of the singularity. (Received August 27, 2013)

1094-35-382 **Vlad C Vicol*** (vvicol@math.princeton.edu), Department of Mathematics, Princeton University, Princeton, NJ 08544. *On the local well-posedness of the Prandtl and the hydrostatic Euler equations with multiple monotonicity regions.*

We find a new class of data for which the Prandtl boundary layer equations and the hydrostatic Euler equations are locally in time well-posed. This is joint work with I. Kukavica, N. Masmoudi, and T.K. Wong. (Received August 27, 2013)

1094-35-398 **Mihaela Ignatova**, **Igor Kukavica*** (kukavica@usc.edu), **Irena Lasiecka** and **Amjad Tuffaha**. *On the well-posedness of an interface damped free boundary fluid-structure model.*

We address a fluid-structure system which consists of the incompressible Navier-Stokes equations and a damped linear wave equation defined on two dynamic domains. The equations are coupled through transmission boundary conditions and additional boundary stabilization effects imposed on the free moving interface separating the two domains. First we shall review local existence and uniqueness of solutions for this system. Then we prove that given sufficiently small initial data there exists a global-in-time solution. (Received August 27, 2013)

1094-35-400 **Surya Prasath***, Department of Computer Science, University of Missouri-Columbia, Columbia, MO 65211, and **Dmitry Vorotnikov** and **Jose A. I. Martinez**. *Global dissipative solutions for generalized forward-backward diffusion equations.*

We consider a generalized nonlinear parabolic diffusion equation arising in image processing problems. Based on the well-known Perona-Malik equation, a coupled PDE is derived by introducing a constraint on the original diffusion coefficient. Unlike other classical forward-backward diffusion problems which are known to be ill-posed, this Dirichlet initial-boundary value problem has global in time dissipative solutions (in a sense going back to P.-L. Lions). We provide several properties of these solutions as well. (Received August 28, 2013)

1094-35-405 **Michael Hitrik*** (hitrik@math.ucla.edu), Department of Mathematics UCLA, Los Angeles, CA 90095-1555. *Spectra for semiclassical operators in dimension two.*

We study the distribution of eigenvalues of perturbed semiclassical operators with a periodic classical flow, in dimension two. In the case of selfadjoint perturbations, we obtain the complete asymptotics for individual eigenvalues in subclusters, corresponding to regular values of the averaged leading symbol of the perturbation. In the case of non-selfadjoint perturbations, we establish an asymptotic formula of Weyl type for the number of eigenvalues in a spectral band, bounded from above and from below by levels corresponding to such regular values. This talk is based on joint works with M. Hall and J. Sjöstrand. (Received August 28, 2013)

1094-35-406 **Nathan E Glatt-Holtz*** (negh@vt.edu), Department of Mathematics, Virginia Tech, McBryde 428, Blacksburg, VA 24060. *Ergodic results for the Boussinesq system with degenerate random forcing.*

We establish the existence and uniqueness of an ergodic invariant measure for the Boussinesq Equations in the presence of a very degenerate stochastic forcing acting only in the density equation and only at the largest spatial scales. The central challenge of the work is to establish certain smoothing properties of the Markovian dynamics associated to this system. Towards this aim we encounter an unusual Lie bracket structure in the associated vector fields and thus develop a novel sense for which the classical 'Hormander condition' is satisfied. In turn this bracket structure leads to new challenges for the spectral analysis of a certain central object, the Malliavin covariance matrix. This is joint work with J. Foldes (IMA-Minnesota), G. Richards (Rochester) and E. Thomann (Oregon State). (Received August 28, 2013)

37 ► Dynamical systems and ergodic theory

1094-37-12 **Daniel W. Cranston** and **Candace M. Kent*** (cmkent@vcu.edu), Virginia Commonwealth University, Dept. of Mathematics and Applied Mathematics, 1015 Floyd Avenue, Richmond, VA 23284-2014. *On the Boundedness of Positive Solutions of a Reciprocal Max-Type Difference Equation with Periodic Parameters.* Preliminary report.

We investigate the boundedness of positive solutions of the reciprocal max-type difference equation

$$x_n = \max\left\{\frac{A_{n-1}^1}{x_{n-1}}, \frac{A_{n-1}^2}{x_{n-2}}, \ldots, \frac{A_{n-1}^t}{x_{n-t}}\right\}, \quad n = 1, 2, \ldots,$$

where, for each value of i, the sequence $\{A_n^i\}_{n=0}^{\infty}$ of positive real numbers is periodic with period p_i. We give both sufficient conditions on the p_i's for the boundedness of all solutions and sufficient conditions for all solutions to be unbounded. This work essentially complements the work of Bidwell and Franke (2008), who showed that as long as every positive solution of our equation is *bounded*, then every positive solution is eventually periodic, thereby leaving open the question as to when solutions are bounded. We also briefly discuss the potential applications of this work to the biological area of morphogenesis. (Received June 18, 2013)

1094-37-128 **Nikolai Chernov** and **Sandro Vaienti** (hongkunz@gmail.com), Amherst, MA 01002, and **Hong-Kun Zhang*** (hongkunz@gmail.com), University of Massachusetts Amherst, Amherst, MA 01003. *Optimal bound for decay of correlations of nonuniformly hyperbolic systems.*

We investigate the decay rate of correlations for nonuniformly hyperbolic systems with singularities, which include chaotic billiards, for piecewise Hölder observables. By constructing a completely new scheme of coupling according to certain stopping times we obtain optimal bounds for the decay rate of correlations. Our results are applied to certain classes of billiards and linked-twist (Received August 18, 2013)

1094-37-142 **Olga Lukina*** (lukina@uic.edu), 322 SEO (M/C 249), 851 S. Morgan Street, Chicago, IL 60607. *Hausdorff dimension of matchbox manifolds.*

Matchbox manifolds are a class of foliated spaces where transversal models are totally disconnected. In the talk, we investigate properties of transverse Hausdorff dimension, as well as lower and upper box dimensions, for a special class of matchbox manifolds, where the transverse dynamics is described by a pseudogroup action on a space of pointed trees. We present examples of matchbox manifolds with finite and infinite Hausdorff dimension. (Received August 20, 2013)

1094-37-191 **Steven Hurder*** (hurder@uic.edu), Department of Mathematics, 322 SEO, M/C 249, 851 S. Morgan Street, Chicago, IL 60607-7045. *Lipshitz matchbox manifolds.*

A matchbox manifold is a connected, compact foliated space with totally disconnected transversals. A minimal matchbox manifold is said to be Lipshitz if there exists a metric on a Cantor set transversal, for which the holonomy maps are Lipshtiz. Examples of Lipshitz matchbox manifolds include the exceptional minimal sets for C^1-foliations of compact manifolds, the classical solenoids, and the weak solenoids of McCord and Schori, among others. We address the question: When does a Lipshitz matchbox manifold admit an embedding as a minimal set for a smooth dynamical system, or more generally for a C^1-foliation of a smooth compact manifold? We also discuss the classification theory for Lipshitz weak solenoids. (Received August 23, 2013)

1094-37-238 **Rafael de la Llave** and **Nikola P Petrov*** (npetrov@ou.edu), Department of Mathematics, University of Oklahoma, 601 Elm Avenue, Norman, OK 73034, and **Arturo Olvera**. *Shadowing with localization, and applications to renormalization.*

We present a quantitative shadowing theorem that works for infinite dimensional discrete dynamical systems that are not necessarily invertible. The theorem does not require that the pseudo-orbit considered is hyperbolic, but only approximately so. It obtains localization properties: if the pseudo-orbit fails to be an orbit at some isolated times, the changes needed to make it an orbit are exponentially localized around these times; similarly for the approximately hyperbolic properties. The main technical tool to verify the hypothesis of the shadowing theorem is a delicate "lambda-lemma" that works in the generality considered.

As an application, we show that, if a map in a Banach space has two hyperbolic fixed points p_{A} and p_{B} such that the unstable manifold of each point intersects transversely the stable manifold of the other, then there exist orbits that stay close to the fixed points for any sequence of times we want.

Using this application for renormalization group operators, we show that some geometric properties of the renormalization-group dynamics (heteroclinic intersections of invariant manifolds of fixed points) imply certain asymptotic relations among universal scaling exponents – a fact observed numerically by the authors. (Received August 25, 2013)

1094-37-320 **Romain Aimino** (aimino@cpt.univ-mrs.fr), **Matthew Nicol*** (nicol@math.uh.edu) and **Mike Todd** (mjt20@st-andrews.ac.uk). *Recurrence statistics for the space of Interval Exchange Maps and the Teichmüller flow on the space of translation surfaces.* Preliminary report.

We show that the transfer operator of the Rauzy-Veech-Zorich renormalization map for interval exchange transformations acting on a space of quasi-Hölder functions is quasicompact and derive certain statistical recurrence properties for this map and its associated Teichmüller flow. We establish Borel-Cantelli lemmas, extreme value

statistics and return time statistics for the map and flow. This is joint work with Romain Aimino and Mike Todd. (Received August 26, 2013)

1094-37-327 **Alexander Grigo*** (grigo@math.ou.edu), Department of Mathematics, University of Oklahoma, Norman, OK 73019. *On Certain Non-Hamiltonian Billiard-like Models in Statistical Mechanics.*

Classical billiards are special models of classical mechanics for which many rigorous results are available. In particular, dispersive billiards have strong statistical properties and are widely used as fundamental models of (classical) statistical mechanics. In this talk it will be shown how certain non-Hamiltonian systems arising in models of statistical mechanics can be reduced to billiard-like dynamical systems. Using techniques from classical dispersive billiards, statistical properties for these models are derived and are complemented by numerical studies. (Received August 26, 2013)

1094-37-343 **Luc Rey-Bellet*** (luc@math.umass.edu), University of Massachusetts Amherst, Dept of Mathematics and Statistics, 710 N Pleasant Street, Amherst, MA 01060. *Time reversal symmetry breaking in dynamical systems.*

The symmetry under time reversal is a fundamental property in dynamical systems of physical origin. We discuss this property and the related concept of entropy production which singles out an observable which measure the possible spontaneous symmetry breaking of the time reversal. We discuss the fluctuations properties of this observables by using both spectral methods and the thermodynamical formalism. Several illustrative examples will be provided. (Received August 27, 2013)

1094-37-352 **Nicolai Haydn** (nhaydn@math.usc.edu), **Matthew Nicol** (nicol@math.uh.edu), **Sandro Vaienti** (vaienti@cpt.univ-mrs.fr) and **Licheng Zhang*** (zhanglic@math.uh.edu), Department of Mathematics, University of Houston, 4800 Calhoun Rd, Houston, TX 77004. *Central limit theorems for the shrinking target problem.*

We establish central limit theorems for the shrinking target problem for generic points in a variety of hyperbolic dynamical systems. More precisely suppose $B_i := B(p, r_i)$ are nested balls of radius r_i about a point p in a dynamical system (T, X, μ). In many dynamical settings it has been shown that if $E_n := \sum_{i=1}^{n} \mu(B_i)$ diverges then $\lim_{n\to\infty} \frac{1}{E_n} \sum_{j=1}^{n} 1_{B_i}(T^i x) \to 1$ for μ a.e. $x \in X$. This is a self-norming type of strong law of large numbers called the Strong Borel-Cantelli property. We establish self-norming central limit theorems (CLT) of the form $\lim_{n\to\infty} \frac{1}{a_n} \sum_{i=1}^{n} [1_{B_i}(T^i x) - \mu(B_i)] \to N(0, 1)$ (in distribution) for generic points $p \in X$ for certain hyperbolic dynamical systems, where the normalization constants are $a_n^2 \sim E[\sum_{i=1}^{n} 1_{B_i}(T^i x) - \mu(B_i)]^2$. (Received August 27, 2013)

1094-37-370 **Andrew Torok*** (torok@math.uh.edu) and **Viorel Nitica**. *Stable transitivity for Heisenberg group extensions of hyperbolic systems.*

Consider skew-extensions with fiber the standard real Heisenberg group $\mathcal{H}_n$ of a uniformly hyperbolic dynamical system. We show that among the C^r extensions ($r > 0$) that avoid an obvious obstruction, those that are topologically transitive contain an open and dense set. More precisely, we show that an $\mathcal{H}_n$-extension is transitive if and only if the $\mathbb{R}^{2n}$-extension given by the abelianization of $\mathcal{H}_n$ is transitive.

In order to obtain this we prove a Diophantine approximation result for simultaneous solutions of a quadratic form and several linear forms. (Received August 27, 2013)

1094-37-403 **GREGORY GALPERIN*** (ggalperin@eiu.edu), EASTERN ILLINOIS UNIVERSITY, 600 Lincoln Ave., Charleston, IL 61920. *A billiard particle bouncing off the scatterers in a gravitational field.*

A billiard particle drops down in a vertical (almost) constant gravitational field in 3D space and reflects elastically by the billiard reflection law from infinitely many bounded disjoint scatterers located at a horizontal plane (horizontal line in the 2D case) and enumerated by positive integers. The symbolic sequence for a given billiard trajectory (orbit) is the infinite sequence of the scatterers that reflect the particle moving along this orbit. We will prove that under some natural convexity conditions imposed on the scatterers, all possible symbolic one- and two-sided sequences (a_i) satisfying, for an arbitrary positive number M, the inequality $|a_i - a_{i+1}| < M$ can be realized by billiard trajectories. In particular, the scatterers can be hemispheres or ellipsoids of different sizes in the 3D space, or semicircles or ellipses in the 2D plane. The symbolic sequence can be, for example, the 2-sided sequence ...82818281723141592 65... – the union of the numbers e and π – which can be realized by a billiard orbit. Topological and variational principles will be applied in the proof of that result. (Received August 28, 2013)

39 ► Difference and functional equations

1094-39-60 **Paul Eloe*** (peloe1@udayton.edu) and **Zi Ouyang**. *A Solution Algorithm for Linear Fractional Difference Equations.*

We consider linear fractional difference equations of the form,

$$\nabla_0^{\nu_1} y(t) + ay(t) = f, \tag{1}$$

or

$$\nabla_0^{\nu_2} y(t) + a\nabla_0^{\nu_1} y(t) + by(t) = f,$$

where a and b are constants, f denotes a nonhomogeneous term and $\nu_2 > \nu_1 > 0$. ∇_0^{ν} represents a Riemann-Liouville fractional backward difference operator. A solution algorithm is constructed by using a discrete transform method. When applied to (1), the algorithm is not new. Sufficient conditions in terms of a or a and b for convergence of the formal solutions are given. (Received August 06, 2013)

1094-39-140 **Kevin Ahrendt***, Kevin Ahrendt, Math Department - 203 Avery Hall, University of Nebraska-Lincoln, Lincoln, NE 68588. *On the Asymptotic Properties of the Generalized Exponential Function over Isolated Time Scales.*

A time scale is a nonempty, closed subset of $\mathbb{R}$ denoted by $\mathbb{T}$ for which a calculus can be developed. We define the solution to $y^{\Delta} = p(t)y$ to be the generalized exponential function. In this work, we consider the generalized exponential function $e_z(t, t_0)$ on isolated time scales where the exponent z is a complex number. We show several asymptotic properties of the generalized exponential function. In particular, we prove several theorems that define the regions of convergence of the exponential $e_z(t, t_0)$ to 0 as well as regions of divergence in the complex plane. (Received August 19, 2013)

1094-39-181 **Murat Adivar**, **Elvan Akin** and **Raegan Higgins*** (raegan.higgins@ttu.edu). *Oscillatory Behavior of Solutions of Third-Order Delay and Advanced Dynamic Equations on Time Scales.*

One important method for studying the oscillation of higher-order differential equations is to make a comparison with first-order differential equations. The method involves using the monotonicity of the operator. In this talk we show how such a method can be applied to a class of third-order delay dynamic equations on time scales. In particular, it is shown that the nonexistence of an eventually positive solution of a certain first-order delay dynamic equation is sufficient for oscillation of third-order delay dynamic equations. (Received August 22, 2013)

1094-39-354 **Heather B Hunt*** (hbhunt01@louisville.edu), 328 Natural Sciences Building, University of Louisville, Louisville, KY 40292, and **Prasanna K Sahoo**. *A Linear Functional Equation on Groups.*

Let G be any arbitrary group and $\mathbb{C}$ the field of complex numbers. We will present the general solution $f : G \times G \to \mathbb{C}$ of the functional equation

$$f(pr, qs) + f(ps, qr) = 2f(p, q) + 2f(r, s)$$

for all $p, q, r, s \in G$, using the solution of the functional equation $f(pq) + f(qp) = 2f(p) + 2f(q)$ for all $p, q \in G$. (Received August 27, 2013)

1094-39-369 **Harold M Hastings*** (harold.hastings@hofstra.edu). *Stochastic differential and difference equation models for extinction or collapse.* Preliminary report.

This talk will discuss stochastic differential and difference equation models for extinction or collapse in model ecological and economic systems. (Received August 27, 2013)

41 ► Approximations and expansions

1094-41-30 **Palle Jorgensen*** (palle-jorgensen@uiowa.edu), Dept Mathematics, MLH, University of Iowa, Iowa City, IA 52242. *Multiresolutions and operator theory.*

Typically the Hilbert space for wavelet expansions is $L^2(R^d)$. But there are other choices that naturally present themselves, both from the point of view of operator theory and its applications.

These other Hilbert spaces are dictated by the geometry of the context, and the nature of scaling identity, and of resolution/detail systems at hand. Our results include: both old and new constructions in geometric measure theory, in iterated function systems, and finally a new stability theorem for wavelets. Our theory still begins with an analysis of subspaces invariant under translations by the lattice Z^d, and with an associated

multiplicity function. We will further sketch recent joint work where our multiplicity analysis takes the form of a fibered bundle, with an infinite-dimensional group acting naturally over each fiber. This generalizes a formulation which originated in other joint research of the speaker with Ola Bratteli, within the more traditional context of multiresolutions. In this case, the multiplicity is one, and our group acts transitively on the family of all wavelet filters. (Received July 18, 2013)

1094-41-295 **Mishko Mitkovski***, Department of Mathematical Sciences, Clemson University, SC.
Toeplitz operators and basis properties of special functions.

We will present a connection between basis properties of some classical systems of special functions and the invertibility properties of certain associated Toeplitz operators. We use this connection to derive new and recover some old density results. The method used is a blend of complex analysis, haromonic analysis, and operator theory. (Received August 26, 2013)

1094-41-392 **Shidong Li*** (shidong@sfsu.edu), Department of Mathematics, San Francisco State University, San Francisco, CA 94132, and **Tiebin Mi** (mitiebin@gmail.com), School of Information, Renmin University of China, Beijing, 100081, Peoples Rep of China.
Optimal-dual-frame based analysis approaches for compressed sensing with coherent frames. Preliminary report.

Optimal-dual-frame based ℓ_1 analysis approaches will be discussed for effective signal recovery when sparse frame expansions are expected. The notion of blind optimal-dual-frame based analysis approach is shown to be equivalent to the conventional ℓ_1 synthesis method. This equivalency observation provides an recovery guarantee that does not depend on the accurate recovery of the (frame expansion) coefficients. A notion of sparsity-inducing dual frames (sparse duals) is also proposed for more effective signal recovery. Basic properties of sparse duals, a sparse-dual-based ℓ_1-analysis approach and its performance analysis are discussed. Examples will be provided. (Received August 27, 2013)

42 ► Fourier analysis

1094-42-2 **Ronny Hadani*** (hadani@math.utexas.edu), 1 University station C1200, Austin, TX 78712.
Representation theoretic patterns in three dimensional cryo-electron microscopy.

Three dimensional cryo-electron microscopy is the problem of determining the 3D structure of a large molecule from the set of electron microscopy images of randomly oriented and positioned identical molecules, frozen in a thin layer of ice. A solution to this problem is interesting, as it promises to be an entirely general technique which does not require crystallization or other special preparation stages. Present approaches to the problem fail with particles that are too small, images that are too noisy or when signal-to-noise ratio becomes too low. The focus of my talk is the intrinsic reconstitution algorithm, due to Singer and Shkolnisky, which constitutes a basic step for the solution of the 3D cryo-EM problem and whose main appealing property is its remarkable numerical stability to noise. My goal is to give an introductory explanation of the mathematical principles underlying this novel algorithmic approach, while hinting about their generalization and application to other fundamental problems in cryo-EM and beyond. Along the way, I will describe the mathematical model underlying the experimental set-up, specifying the main computational problems/technical difficulties that should be resolved as part of three dimensional structure determination from cryo-EM images. (Received August 20, 2013)

1094-42-15 **Christopher Michael Wedrychowicz*** (cwedrych@saintmarys.edu) and **Anna Savvopoulou** (annsavvo@iusb.edu).
On the weak-type (1, 1) of the uncentered Hardy–Littlewood maximal operator associated with certain measures on the plane.

Suppose μ is a positive measure on R^2 given by $\mu = \nu \times \lambda$, where ν and λ are Radon measures on S^1 and R^+, respectively, which do not vanish on any open interval. We prove that if for either ν or λ there exists a set of positive measure A in its domain for which the upper and lower $s-$densities, $0 < s \leq 1$, are positive and finite for every $x \in A$ then the uncentered Hardy–Littlewood maximal operator M_μ is weak-type (1, 1) if and only if ν is doubling and λ is doubling away from the origin. This generalizes results of Vargas concerning rotation-invariant measures on R^n when $n = 2$. (Received June 26, 2013)

1094-42-33 **John J Benedetto*** (jjb@math.umd.edu), Norbert Wiener Center, Department of Mathematics, University of Maryland, College Park, MD 20742, and **Enrico Au-Yeung**.
Balayage and short-time Fourier transform frames. Preliminary report.

Preliminaries for our main theorem use deep results from Beurling's theory of balayage, as well as the Wiener-Beurling theory of spectral synthesis and Riemann's ideas related to sets of uniqueness. Our main theorem

is a non-uniform Gabor frame theorem, and it is quantitatively compared with an analogous theorem due to Grochenig. (Received July 20, 2013)

1094-42-41 **Morten Nielsen** and **Hrvoje Šikić*** (hsikic@math.hr). *Bases of translates and BMO.*
A family of integer translates of a square integrable function forms a basic sequence if and only if the periodization function satisfies the Muckenhoupt A(2) condition. We develop a study of the periodization function from the point of view of the theory of A(p) weights. There is a well-known connection of such weights with the BMO space. Observe that those periodization functions that correspond to bounded functions via the BMO connections, are precisely the one that generate Riesz bases of translates. We are particularly interested in the ones which do not have that property, since they give us an additional insight into a class of conditional Schauder bases of translates. We employ the Garnett-Jones distance to identify some of the subclasses in this family. (Received July 25, 2013)

1094-42-42 **Bin Han*** (bhan@ualberta.ca), Department of Math. and Stat. Sciences, University of Alberta, Edmonton, Alberta T6G 2G1, Canada. *Nonhomogeneous and Homogeneous Wavelets and Framelets.* Preliminary report.
For $\Phi, \Psi \subset L_2(R^d)$, define a homogeneous affine system

$$AS(\Psi) := \{\psi_{M^j;k} : j \in Z, k \in Z^d\}$$

and a nonhomogeneous affine system

$$AS_0(\Phi;\Psi) := \{\phi(\cdot - k) : k \in Z^d\} \cup \{\psi_{M^j;k} : j \geq 0, k \in Z^d\},$$

where M is a $d \times d$ matrix and $f_{M^j,k} := |\det(M^j)|^{1/2} f(M^j \cdot - k)$. If $AS(\Psi)$ is a frame (or wavelet) for $L_2(R^d)$, we call $AS(\Psi)$ a homogeneous framelet (or wavelet). Though homogeneous wavelets/framelets have been extensively studied, nonhomogeneous wavelets/framelets have intrinsic cascade structure and can be constructed via Oblique Extension Principle. We discuss the relations between nonhomogeneous and homogeneous wavelets and framelets. On one hand, we see that every nonhomogeneous wavelet or framelet always leads to a homogeneous wavelet or framelet. For example, if $AS_0(\Phi;\Psi)$ is a frame for $L_2(R^d)$, then $AS(\Psi)$ must be a frame for $L_2(R^d)$ with the same lower and upper frame bounds. Moreover, we show that a nonhomogeneous wavelet naturally leads to multiresolution analysis and filter banks. On the other hand (the harder direction), under the assumption of refinable structure, we see that every homogeneous wavelet or framelet must come from a nonhomogeneous wavelet or framelet. (Received July 25, 2013)

1094-42-43 **DEMETRIO LABATE*** (dlabate@math.uh.edu), 651 Phillip G Hoffman, Department of Mathematics, University of Houston, Houston, TX 77204-3008, and **KANGHUI GUO** (kanghuiguo@missouristate.edu), Department of Mathematics, Missouri State University, Springfield, MO 65804. *Shearlet methods for the analysis of singularities.*
The classical wavelet transform is a remarkably effective tool for the analysis of point-wise regularity of functions and distributions. During the last decade, the emergence of a new generation of multiscale representations - most notably the shearlet representation - has extended the classical wavelet approach leading to a class of generalized wavelet transforms which offer a much more powerful framework for microlocal analysis. In this talk, we show that the shearlet transform provides a precise geometric characterization of the set of singularities of a large class of multidimensional functions and distributions, going far beyond the capabilities of the classical wavelet transform. These properties provide the theoretical underpinning for several state-of-the-art applications from signal processing and sparse data representations. (Received July 28, 2013)

1094-42-66 **Alexander (Oleksandr) V Tovstolis*** (atovstolis@math.okstate.edu), Department of Mathematics, Oklahoma State University, 401 Mathematical Sciences, Stillwater, OK 74078. *Norm estimates for the Hadamard product operator on Hardy and Bergman spaces.*
The **Hadamard Convolution**, or **Hadamard Product**, of two harmonic functions f and g in the unit disk $\mathbb{D}$ of the complex plane

$$f\left(re^{i\theta}\right) = \sum_{n=-\infty}^{\infty} a_n r^{|n|} e^{in\theta}, \quad g\left(re^{i\theta}\right) = \sum_{n=-\infty}^{\infty} b_n r^{|n|} e^{in\theta}, \quad r \in [0,1),\, \theta \in \mathbb{R},$$

is defined by

$$(f * g)\left(re^{i\theta}\right) = \sum_{n=-\infty}^{\infty} a_n b_n r^{|n|} e^{in\theta}, \quad r \in [0,1),\, \theta \in \mathbb{R}.$$

If we fix f, we obtain a linear operator

$$f* : \sum_{n=-\infty}^{\infty} b_n r^{|n|} e^{in\theta} \mapsto \sum_{n=-\infty}^{\infty} a_n b_n r^{|n|} e^{in\theta}.$$

For $1 \leq p \leq q \leq \infty$, we investigated the operator $f*$ acting on harmonic (h^p) or holomorphic (H^p) spaces onto h^q or H^q, respectively. For the holomorphic case, estimates for the norm of $f*$ are obtained with $p, q \in (0, \infty]$.

Furthermore, we consider the Hadamard product operator acting on Bergman spaces of harmonic (a^p onto a^p) or holomorphic (A^p onto A^p) functions for $p \in [1, \infty)$, as well as on Hardy spaces (h^p or H^p) onto Bergman spaces a^q or A^q, respectively.

In several cases, the obtained estimates are sharp. (Received August 08, 2013)

1094-42-68 **Matthew Fickus*** (matthew.fickus@gmail.com), Department of Mathematics and Statistics, Air Force Institute of Technology, Wright-Patterson AFB, OH 45433.
Equiangular Tight Frames and the Restricted Isometry Property.

An equiangular tight frame (ETF) is a type of optimal packing of a given number of lines in a Euclidean space of a given dimension. Such frames have minimal coherence, making them attractive for compressed sensing (CS) applications. However, like all known deterministic constructions of matrices, ETFs suffer from the "square-root bottleneck," meaning the degree to which they satisfy CS's restricted isometry property (RIP) pales in comparison to random matrices. For most deterministic constructions, it is unknown whether this bottleneck is simply a consequence of poor proof techniques or, more seriously, a flaw in the matrix design itself. We focus on this issue in the special case of ETFs. In particular, we discuss the degree to which the recently-introduced Steiner and Kirkman ETFs satisfy the RIP. We further discuss how a popular family of ETFs, namely harmonic ETFs arising from McFarland difference sets, are particular examples of Kirkman ETFs. Overall, we find that many families of ETFs are shockingly bad when it comes to RIP, being provably incapable of exceeding the square-root bottleneck. (Received August 08, 2013)

1094-42-137 **Christopher Heil*** (heil@math.gatech.edu), School of Mathematics, Georgia Institute of Technology, Atlanta, GA 30332. *KS may be solved, but HRT is still open.*

The Feichtinger Conjecture states that a redundant frame that is bounded below can be split into a finite number of nonredundant Riesz sequences. Recently, Marcus, Spielman, and Srivastava recently announced a solution to the celebrated Kadison–Singer problem, which Casazza and Tremain have shown is equivalent to the Feichtinger Conjecture. In this talk we will give a status report on another conjecture that is still open and involves frames and finiteness. This is the HRT Conjecture, which states that any finite set of time-frequency translates of a given L^2 function must be linearly independent. (Received August 19, 2013)

1094-42-146 **Dorin Ervin Dutkay*** (ddutkay@gmail,com), Orlando, FL 32816. *Fuglede's conjecture in dimension one.*

The Fuglede conjecture relates the harmonic analysis of Fourier bases with the geometry of tilings. Even though the Fuglede conjecture was disproved in both directions for dimensions higher than three, in dimension one, there is a lot of evidence that it might be true. We present some of these results and some of the reductions of the conjecture to integers or to finite abelian groups. (Received August 20, 2013)

1094-42-155 **Ilya A. Krishtal*** (ikrishtal@niu.edu), Department of mathematical Sciences, Watson Hall 320, DeKalb, IL 60115. *Dynamical sampling of evolving signals.*

I will discuss basic ideas of dynamical sampling, which is a new approach for processing signals that evolve in time. The main idea is that in many cases one can compensate for insufficient spacial sampling density by utilizing samples obtained at different time levels. The talk is based on joint work with A. Aldroubi and J. Davis. (Received August 21, 2013)

1094-42-179 **Marcin Bownik** and **Brody Dylan Johnson*** (brody@slu.edu). *Frame properties of iterated filter banks.* Preliminary report.

The frame properties of a multi-channel, integer-sampled filter bank are well understood using the polyphase representation. Iteration of the analysis stage of such a filter bank leads to a multiscale decomposition of a signal and it becomes natural to ask about the frame properties of the resulting *iterated filter bank*. In the dyadic case, recent work by Bayram and Selesnick relates the frame bounds of non-perfect reconstruction [finitely] iterated filter banks to those of an associated dyadic wavelet frame. The present work continues this line of study by investigating the frame bounds of infinitely iterated dyadic filter banks. (Received August 22, 2013)

1094-42-205 **Bernhard G Bodmann*** (bgb@math.uh.edu), 651 PGH, Department of Mathematics, University of Houston, Houston, TX 77204, and **Gitta Kutyniok** and **Xiaosheng Zhuang**. *Gabor shearlets: tightness, low redundancy and sparse approximations.*

In this talk, we introduce Gabor shearlets, a variant of shearlet systems, which are based on a different group representation than previous shearlet constructions: they combine elements from Gabor and wavelet frames

in their construction. As a consequence, they can be implemented with standard filters from wavelet theory in combination with standard Gabor windows. Unlike the usual shearlets, the new construction can achieve a redundancy as close to one as desired. Our construction follows the general strategy for shearlets. First we define group-based Gabor shearlets and then modify them to a cone-adapted version. In combination with Meyer filters, the cone-adapted Gabor shearlets constitute a tight frame and provide low-redundancy sparse approximations of cartoon-like functions. (Received August 23, 2013)

1094-42-282 **Alexander M. Powell*** (alexander.m.powell@vanderbilt.edu), Vanderbilt University, Department of Mathematics, Nashville, TN 37240, and **J. Tyler Whitehouse**. *Consistent reconstruction and random polytopes.*

Consistent reconstruction is a linear programming approach for estimation problems involving bounded noise (for example, the problem of reconstructing a signal from a set of quantized linear measurements). We prove new mean squared error bounds for consistent reconstruction in the setting of random frames and under the uniform quantization noise model. In particular, we prove that the mean squared error for consistent reconstruction is of the optimal order C/N^2 where N is the number of measurements, and we prove bounds on the associated dimension dependent constant C. Our main results involve an analysis of random polytopes and of associated coverage processes on the sphere. (Received August 26, 2013)

1094-42-290 **Kasso Okoudjou*** (kasso@math.umd.edu), Department of Math, Math Blg, College Park, MD 20742. *Scalable frames.* Preliminary report.

A finite frame for $\mathbb{R}^d$ is scalable if its vectors can be scaled by nonnegative numbers to yield a tight frame. In this talk, two equivalent characterizations of the class of scalable frames will be given. The first characterization is based on Fritz John's ellipsoid theorem while the second involves optimizing certain functional of the frame. Together, these two characterizations give a geometrical as well as a numerical conditions for a frame to be scalable. This talk is based on joint work with X. Chen, G. Kutyniok, F. Philipp, and R. Wang. (Received August 26, 2013)

1094-42-297 **Shahaf Nitzan*** (shahaf.n.h@gmail.com) and **Gady Kozma**. *Combining Riesz Bases.*

In many settings orthonormal bases (ONB) are not easy to come by. It is known, for example, that even the union of as few as two intervals may not admit an ONB of exponentials. In cases where there are no ONB, the next best option is a Riesz basis (i.e. the image of an ONB under a bounded invertible operator). In this talk we will discuss the following question: Does every finite union of intervals admit a Riesz basis of exponentials? (Received August 26, 2013)

1094-42-302 **Ronald R Coifman*** (coifman@math.yale.edu), Dept of Mathematics Yale, 10 Hillhouse Ave, New Haven, CT 06520. *Harmonic Analysis Tensor wavelets and smoothness of Database.*

We show that given a matrix or database can be equipped with two geometries in duality , one on the rows the other on the columns so as to to minimize appropriate Besov norms of the matrix. This method is applied to provide fast numerical analysis , as well as to organize text documents. Relations to duality for smoothness class and Earth mover distances are essential . joint work with M Gavish, and A Haddad. (Received August 26, 2013)

1094-42-312 **Nader Motee** (nam211@lehigh.edu), Mechanical Engineering & Mechanics, Lehigh University, Bethlehem,, PA 18015, and **Qiyu Sun*** (qiyu.sun@ucf.edu), Department of Mathematics, University of Central Florida, Orlando, FL 32816. *Sparsity of spatially decaying matrices.*

In this talk, we will introduce a new algebra for sparsity of spatially decaying matrices, establish Wiener's lemma for that algebra, and solve Lyapunov and Riccati equations in that algebra. (Received August 26, 2013)

1094-42-315 **Rodolfo H. Torres*** (torres@math.ku.edu) and **Erika Ward**. *Leibniz's Rule, Sampling, and Wavelets on Mixed Lebesgue Spaces.*

We will present several results about Leibniz's rule, sampling, and wavelets in the context of mixed Lebesgue spaces. (Received August 26, 2013)

1094-42-336 **Leonid Slavin*** (leonid.slavin@uc.edu). *Exponential estimates for square functions on α-trees.*

I will present new exponential estimates that use the dyadic square function and generalize the Chang-Wilson-Wolff theorem. These estimates translate to α-trees, which are constructs similar to dyadic grids, but with less

rigidity. In turn, such trees arise on spaces of homogeneous type, thus enabling new exponential analysis in such settings. (Received August 27, 2013)

1094-42-407 **Yang Wang*** (ywang@math.msu.edu), 5228 MADISON AVE, APT A5, Okemos, MI 48864.
The Phase Retrieval Problem.

The classic phase retrieval problem refers to the reconstruction of a function from the magnitude of its Fourier transform. It amounts to reconstructing the phase information of the Fourier transform from magnitude only, and hence the term "phase retrieval". A more general version of the phase retrieval problem is to whether an element in a Hilbert space is determined the magnitudes of certain inner products. Phase retrieval has seen growing applications in signal processing and particularly in many imaging problems. Today phase retrieval problem has been extended to the more general problem of reconstructing a function (an image or a signal) from the magnitude of some transform of it.

Substantial progress on phase retrieval has been made in recent years both in theory and applications. Nevertheless there remains numerous open problems, many appears to be extremely challenging. In this talk, I'll give an overview of the phase retrieval problem and present some of the latest advances as well as open problems in the area. (Received August 28, 2013)

43 ► Abstract harmonic analysis

1094-43-6 **Alan L. Paterson*** (apat1erson@gmail.com). *The Fourier-Stieltjes algebra of a locally compact groupoid.*

The Fourier-Stieltjes algebra $B(G)$ of a locally compact group G has been much studied, and it is natural to ask if this theory can be extended to the case of a locally compact groupoid G. Fundamental work in this direction was done in papers by J. Renault and by A. Ramsay and M. Walter. The talk will describe how one can develop the theory using the disintegration theorem of Renault-Muhly-Williams and operator space theory, showing in particular how three familiar characterizations of $B(G)$ in the group case - $B(G)$ as the span of positive definite functions, as a dual space and as a space of completely bounded maps - extend in complete generality to the groupoid case. (Received April 13, 2013)

1094-43-16 **Currey Bradley**, **Mayeli Azita** and **Vignon Oussa***, 131 Summer Street, Bridgewater, MA 02325. *Decomposition of Wavelet Representations.*

The concepts of wavelet sets were used by Lim, Packer and Taylor to obtain a direct integral decomposition of the wavelet representation of a discrete group associated to an arbitrary integer dilation matrix. The discrete group considered is the semi-direct product group : $\mathbb{Q}_A \rtimes \langle A \rangle$ where $\mathbb{Q}_A$ is a subgroup of $\mathbb{Q}^d$. In this talk, we will present decompositions of wavelet representations when it is not assumed that the normal subgroup of the semidirect product group is commutative. More precisely, let N be a simply connected connected nilpotent Lie group with a rational structure. Let Γ be a uniform subgroup of N and let $\alpha \in \mathrm{Aut}(N)$. We will obtain a decomposition of the so called wavelet representation $W : \cup_{k\in\mathbb{Z}} \alpha^k(\Gamma) \rtimes \langle \alpha \rangle \to U\left(L^2(N)\right)$ defined such that $W(\gamma, 1)$ acts by left translation and $W(1, \alpha)$ acts by dilation on $L^2(N)$. This is a joint work with Bradley Currey and Azita Mayeli. (Received June 30, 2013)

45 ► Integral equations

1094-45-51 **M. N. Islam*** (mislam1@udayton.edu), Department of Mathematics, University of Dayton, Dayton, OH 45469-2316. *Asymptotically stable solutions of a nonlinear integral equation.* Preliminary report.

In this paper the existence of asymptotically stable solutions of the nonlinear Volterra integral equation

$$x(t) = f(t, x(t)) + \int_0^t K(t, s)g(s, x(s))ds.$$

is studied employing Schauder's fixed point theorem as the primary mathematical tool of analysis. (Received August 01, 2013)

46 ► Functional analysis

1094-46-8 **Jean N Renault*** (jean.renault@univ-orleans.fr). *Hypergroupoid C*-algebras.* Preliminary report.

I will introduce a class of locally compact hypergroupoids with Haar systems and give the construction of their C*-algebras. This construction, which is a straightforward generalization of groupoid C*-algebras, includes Hecke C*-algebras and other hypergroups. (Received April 27, 2013)

1094-46-20 **Dongyang Chen** and **Bentuo Zheng*** (bzheng@memphis.edu), Department of Mathematical Sciences, University of Memphis, Memphis, TN 38152. *Lipschitz p-nuclear operators.*

We introduce the notion of Lipschitz p-nuclear operators and show that for a linear operator, the Lipschitz p-nuclear norm is the same as its usual p-nuclear norm under certain conditions. We also prove that the Lipschitz p-integral norm of a Lipschitz map from a finite metric space into a Banach space is the same as its Lipschitz p-nuclear norm. (Received July 10, 2013)

1094-46-37 **Lindsey M. Woodland*** (lmwvh4@mail.missouri.edu), Department of Mathematics, University of Missouri, Columbia, MO 65211-1400, **Peter G. Casazza** (casazzap@missouri.edu), Department of Mathematics, University of Missouri, Columbia, MO 65211-1400, **Richard G. Lynch** (rgiz82@mail.missouri.edu), Department of Mathematics, University of Missouri, Columbia, MO 65211-1400, and **Janet C. Tremain** (tremainjc@missouri.edu), Department of Mathematics, University of Missouri, Columbia, MO 65211-1400. *Integer Frames.*

Finite frame theory has become a powerful tool for many applications of mathematics. In this paper we introduce a new area of research in frame theory: Integer frames. These are frames having all integer coordinates with respect to a fixed orthonormal basis for a Hilbert space. Integer frames have potential to mitigate quantization errors and transmission losses as well as speeding up computation times. This paper gives the first systematic study of this important class of finite Hilbert space frames. (Received July 24, 2013)

1094-46-39 **Peter G. Casazza*** (casazzap@missouri.edu), Department of Mathematics, University of Missouri, Columbia, MO 65211-1400, **Jameson Cahill** (jameson.cahill@gmail.com), Department of Mathematics, University of Missouri, Columbia, MO 65211-1400, **Jesse Peterson** (peterson.jesse.d@gmail.com), Department of Mathematics and Statistics, Air Force Institute of Technology, Wright-Patterson Air Force Base, Dayton, OH 45433, and **Lindsey M. Woodland** (lmwvh4@mail.missouri.edu), Department of Mathematics, University of Missouri, Columbia, MO 65211-1400. *Phase retrieval by projections.*

The problem of recovering a vector from the absolute values of its inner products against a family of measurement vectors has been well studied in mathematics and engineering. A generalization of this phase retrieval problem also exists in engineering: recovering a vector from measurements consisting of norms of its orthogonal projections onto a family of subspaces. There exist semidefinite programming algorithms to solve this problem, but much remains unknown for this more general case. Can families of subspaces for which such measurements are injective be completely classified? What is the minimal number of subspaces required to have injectivity? How closely does this problem compare to the usual phase retrieval problem with families of measurement vectors? In this paper, we answer or make incremental steps toward these questions. We provide several characterizations of subspaces which yield injective measurements, and through a concrete construction, we prove the surprising result that phase retrieval can be achieved with $2M-1$ projections of arbitrary rank in $\mathbb{H}_M$. Finally we present several open problems as we discuss issues unique to the phase retrieval problem with subspaces. (Received July 24, 2013)

1094-46-74 **Timur Oikhberg*** (oikhberg@illinois.edu) and **Eugeniu Spinu**. *Subprojectivity of Banach spaces.*

A Banach space X is said to be subprojective if every subspace $Y \subset X$ contains a subspaces Z, complemented in X (all subspaces are assumed to be infinite dimensional and closed). This notion was introduced in the mid-1960's by R.Whitley, who was interested in describing strictly singular and cosingular operators. Hitherto, only a few examples of subprojective spaces have been known. For instance, ℓ_p is subprojective for $1 \le p < \infty$, while $L_p(0,1)$ is subprojective iff $2 \le p < \infty$.

We study the stability of subprojectivity under "natural" operations, such as direct sums or tensor products. Here are some results: (1) The space $B(X)$ is never subprojective. (2) Suppose K is a compact metrizable space, and X is a Banach space. Then $C(K,X)$ is subprojective iff K is countable, and X is subprojective. (3) If E

is a subprojective symmetric sequence space not containing c_0, then the Schattenn space S_E is subprojective. (Received August 10, 2013)

1094-46-86 **Deguang Han*** (deguang.han@ucf.edu), Department of Mathematics, University of Central Florida, Orlando, FL 32816. *Spectrally Uniform Frames.*

In this talk we will discuss the optimal frame problem with respect to the spectral radius measurement, which seems to be a more natural choice when iteration procedure is allowed in the reconstruction. We present a characterization of spectrally optimal frames (one uniform frames) for one erasures, and discuss some problems for the higher erasure cases. (Received August 12, 2013)

1094-46-94 **Valentin Deaconu*** (vdeaconu@unr.edu), Dept of Math & Stat 0084, University of Nevada, Reno, NV 89557, and **Alex Kumjian** (alex@unr.edu), Dept of Math & Stat 0084, University of Nevada, Reno, NV 89557. *Group actions on graphs and groupoids.*

Let the group G act on a directed graph E. If E is row-finite and has no sources, then G acts also on the groupoid $\Gamma = \Gamma(E)$.

Let ρ be the representation of G on the C^*-correspondence $\mathcal{H}_E$ determined by E. Then G acts on the Cuntz-Pimsner algebra $C^*(E) = C^*(\Gamma)$. For example, if G finite acts on the graph with one vertex and n loops, then we get an n-dimensional representation ρ of G and an action on the Cuntz groupoid and on the Cuntz algebra $\mathcal{O}_n$. Our goal is to study the fixed point algebra $C^*(E)^G$ and the crossed product $C^*(E) \rtimes G = C^*(\Gamma \rtimes G)$ when G is compact and E is arbitrary.

If G and E are finite, we prove that $C^*(E) \rtimes G$ is isomorphic to the C^*-algebra of a graph of (minimal) C^*-correspondences, constructed using the orbits in E^0 and E^1 and the characters of the stabilizer groups.

As a consequence, $C^*(E) \rtimes G$ is strongly Morita equivalent to a graph algebra, so its K-theory can be computed. The group G acts also on the core AF-algebra $C^*(E)^{\mathbb{T}}$ and $C^*(E)^{\mathbb{T}} \rtimes G \cong (C^*(E) \rtimes G)^{\mathbb{T}}$. (Received August 13, 2013)

1094-46-98 **Erik Lundberg*** (elundber@math.purdue.edu), 150 N. University Street, West Lafayette, IN 47904. *Self-commutators of Toeplitz operators and isoperimetric sandwiches.*

In, 1985, D. Khavinson obtained a lower bound for the norm of a Toeplitz operator acting on the Smirnov space of a domain. Combining this with Putnam's inequality, he observed that his results imply the classical isoperimetric inequality. We consider self-commutators of Toeplitz operators in the setting of the Bergman space and obtain a lower bound involving the torsional rigidity of the underlying domain. We conjectured an improved version of Putnam's inequality that was recently proved by J-F. Olsen and M. C. Reguera. Combined with our lower bound this implies the classical Saint-Venant isoperimetric inequality. This is joint work with Steve Bell and Tim Ferguson. (Received August 14, 2013)

1094-46-120 **Stephen J Dilworth*** (dilworth@math.sc.edu), **Denka Kutzarova**, **Gilles Lancien** and **N Lovosoa Randrianarivony**. *Asymptotic geometry of Banach spaces and uniform quotient maps.*

Recently, Lima and Randrianarivony pointed out the role of the property (β) of Rolewicz in nonlinear quotient problems, and answered a ten-year-old question of Bates, Johnson, Lindenstrauss, Preiss and Schechtman. In the present paper, we prove that the modulus of asymptotic uniform smoothness of the range space of a uniform quotient map can be compared with the modulus of (β) of the domain space. We also provide conditions under which this comparison can be improved and we give an isomorphic characterization of spaces which can be renormed to have property (β). (Received August 16, 2013)

1094-46-135 **Mikhail I. Ostrovskii*** (ostrovsm@stjohns.edu), Department of Mathematics and Comp.Sci., St. John's University, 8000 Utopia Parkway, Jamaica, NY 11439. *Radon-Nikodým property and thick families of geodesics.*

Banach spaces without the Radon-Nikodým property are characterized as spaces containing bilipschitz images of thick families of geodesics defined as follows. A family T of geodesics joining points u and v in a metric space is called *thick* if there is $\alpha > 0$ such that for every $g \in T$ and for any finite collection of points $r_1, \dots, r_n$ in the image of g, there is another uv-geodesic $\widetilde{g} \in T$ satisfying the conditions: $\widetilde{g}$ also passes through $r_1, \dots, r_n$, and, possibly, has some more common points with g. On the other hand, there is a finite collection of common points of g and $\widetilde{g}$ which contains $r_1, \dots, r_n$ and is such that the sum of maximal deviations of the geodesics between these common points is at least α. (Received August 19, 2013)

1094-46-138 **Radoslaw Adamczak**, **Olivier Guedon**, **Rafal Latala**, **Alexander E. Litvak**, **Krzysztof Oleszkiewicz**, **Alain Pajor** and **Nicole Tomczak-Jaegermann*** (nicole.tomczak@ualberta.ca). *Moment estimates for convex measures.*

The class of so-called convex measures, introduced by Ch. Borell, extends the important class of log-concave measures. We prove positive and negative moment inequalities for convex measures of appropriate parameters. This leads to large deviation and small ball estimates, and approximation of covariance matrix, for convex measures. In the class of log-concave measures the former two estimates were proved by Paouris and the latter by Adamczak-Litvak-Pajor-Tomczak.

The results presented here appeared in the paper published in Electron. J. Probab. 17 (2012), no. 101, 1–19. (Received August 19, 2013)

1094-46-141 **Petr Hajek** (schlump@math.tamu.edu), 6412 Windwood, College Station, 77845, and **Thomas Schlumprecht*** (schlump@math.tamu.edu), Department of Mathematics, Texas A&M University, College Station, TX 77843. *The Szlenk index of $L_p(X)$.*

We find the optimal upper bound on the values of the weak*-dentability index Dz(X) in terms of the Szlenk index Sz(X) of a Banach space X with separable dual. (Received August 20, 2013)

1094-46-145 **S. J. Dilworth** (dilworth@math.sc.edu), Department of Mathematics, University of South Carolina, Columbia, SC 29208, **Denka Kutzarova*** (denka@math.uiuc.edu), Department of Mathematics, University of Illinois at Urbana-Champaign, Urbana, IL 61801, **N. Lovasoa Randrianarivony** (nrandria@slu.edu), Dep. of Mathematics and Computer Science, Saint Louis University, Saint Louis, MO 63103, **J. P. Revalski** (revalski@math.bas.bg), Institute of Mathematics and Informatics, Bulgarian Academy of Sciences, 1113 Sofia, Bulgaria, and **N. V. Zhivkov** (niz@abv.bg), Institute of Mathematics and Informatics, Bulgarian Academy of Sciences, 1113 Sofia, Bulgaria. *Compactly uniformly convex spaces and property (beta) of Rolewicz.*

We study different facets of property (beta) of Rolewicz. We remark that the notions of compact uniform convexity and property (beta) are isometrically equivalent and present new examples of spaces with that property. An estimate of the (beta)-modulus is also given. (Received August 20, 2013)

1094-46-149 **J W Burns*** (jwb19@pitt.edu) and **C Lennard** (lennard@pitt.edu). *Behavior of Typical Derivatives on Certain Sets.* Preliminary report.

Let $(D[0,1], \|\cdot\|_D)$ be the Banach space of functions with everywhere (on [0,1]) existing derivatives such that for any $f \in D[0,1]$, $\|f\|_D := \|f\|_\infty + \|f'\|_\infty < \infty$. Now f' may not be everywhere continuous. However, it is known that the set of these continuities is a dense G_δ set, and in $\mathbb{R}$ it is known that for any dense G_δ set A, we can find a function whose derivative is discontinuous on A^c.

Here we use $\Lambda(u,a)$ to be the oscillation of the function u at the point a. Let E be an arbitrary closed nowhere dense subset of $[0,1]$. Let $G_E := \{f \in D[0,1] : \inf_{x_0 \in E} \Lambda(f', x_0) > 0\}$. Then G_E is a dense open subset of $D[0,1]$, and furthermore, G_E is co-porous in $D[0,1]$. However, much more is actually true, extending to higher dimensional results. (Received August 20, 2013)

1094-46-166 **William B. Johnson***, Department of Mathematics, Texas A&M University, College Station, TX 77843. *The strong rank one density property in atomic Boolean subspace lattices.* Preliminary report.

In this joint work with T. Figiel, we exploit the duality ideas used for studying approximation properties to solve a problem from the 1991 Memoirs of Argyros, Lambrou, and Longstaff [ALL]. If X is a Banach space, a subspace lattice on X is a complete sublattice of the lattice of closed subspaces of X that contains 0 and X. The order is inclusion, so joins are closed linear spans and meets are intersections. Such objects arise naturally in both operator theory and the theory of bases; see [ALL]. A subspace lattice $\mathcal{L}$ on X has the *strong rank one density property* provided the algebra generated by the rank one operators in Alg $\mathcal{L}$ is dense in Alg $\mathcal{L}$ in the strong operator topology. Alg $\mathcal{L}$ is the closed ideal of all bounded linear operators on X that leave every subspace in $\mathcal{L}$ invariant. In [ALL] it was proved that every atomic Boolean subspace lattice-ABSL- having only two atoms on a Banach space has the strong rank one density property. Larson and Wogen gave an example of an ABSL on ℓ_2 that fails the strong rank one density property and all the atoms are one dimensional. We prove we prove that every ABSL having finitely many atoms on a Banach space has the strong rank one density property. (Received August 21, 2013)

1094-46-168 **Ryan M Causey***, Department of Mathematics, Mailstop 3368, Texas A&M University, College Station, TX 77843-3368. *Applications of trees and branches to coordinitization and embedding of elements of certain classes of Banach spaces with bounded Szlenk index.*

We consider conditions on the basis of a Banach space U which guarantee that if a Banach space X with separable dual satisfies upper tree estimates in U, then X embeds into a Banach space with shrinking FDD satisfying upper block estimates in U. We also consider conditions on the basis of a reflexive Banach space U which guarantee that if a separable, reflexive Banach space X satisfies certain tree estimates with respect to U and U^*, then X embeds into a reflexive space with FDD satisfying the corresponding block estimates. We deduce the existence of universal elements with coordinate systems for certain classes of Banach spaces related to the above coordinitization problems. (Received August 21, 2013)

1094-46-184 **Stephen J Dilworth** (dilworth@math.sc.edu) and **Beata Randrianantoanina*** (randrib@miamioh.edu). *Almost transitive and maximal norms in classical Banach spaces.* Preliminary report.

We prove that spaces ℓ_p, $1 < p < \infty, p \neq 2$, do not admit equivalent almost transitive renormings. This answers a problem posed by Deville, Godefroy and Zizler in 1993. We obtain this as a consequence of a new property of almost transitive spaces with a Schauder basis, namely we prove that in such spaces the unit vector basis of ℓ_2^2 belongs to the asymptotic structure.

We also prove that ℓ_p, $1 < p < \infty$, $p \neq 2$, has continuum different renormings with 1-unconditional bases each with a different maximal isometry group, and that every 1-symmetric space other than ℓ_2 has at least a countable number of such renormings. On the other hand we show that spaces ℓ_p, for $1 < p < \infty$, $p \neq 2$, have continuum different renormings each with an isometry group which is not contained in any maximal isometry group of a renorming of ℓ_p. This answers a question of Wood. (Received August 22, 2013)

1094-46-231 **Jonathan H. Brown*** (brownjh@math.ksu.edu). *The Brauer Semigroup of a groupoid and a symmetric imprimitivity theorem.*

In joint work with Geoff Goehle, we define a monoid called the Brauer semigroup for a locally compact Hausdorff groupoid E whose elements consist of Morita equivalence classes of E-dynamical systems. This construction generalizes both the equivariant Brauer semigroup for transformation groups introduced by an Huef et al. and the Brauer group for a groupoid introduced by Kumjian et al. We show that groupoid equivalence induces an isomorphism of Brauer semigroups and that this isomorphism preserves the Morita equivalence classes of the respective crossed products, thus generalizing Raeburn's symmetric imprimitivity theorem. (Received August 25, 2013)

1094-46-267 **Florent P. Baudier*** (florent@math.tamu.edu). *Geometry of layers of cubes: applications in Geometric Group Theory and Nonlinear Geometry of Banach Spaces.*

One can equip the set of all finite subsets of the integers with the symmetric difference metric, i.e. the distance between two finite subsets is the cardinality of their symmetric difference. This metric space, which is isometric to the infinite Hamming cube, and its relatives turn out to be related to important geometric properties of Banach spaces. In this talk, we will give two utilizations of those metrics.

The first application is in geometric group theory. We will show how a tight estimate on the Lebesgue compression (introduced by Guentner and Kaminker) of ℓ_p-spaces can be derived from a beautiful stabilization result of Kalton and Randrianarivony.

The second application occurs in nonlinear geometry of Banach spaces. Given a compact metric space K, we shall establish a link between the Cantor-Bendixson index of K and the $\mathcal{C}(K)$-distortion of the set of subsets of the integers with at most k elements equipped with the symmetric difference metric, denoted $\Delta_{\leq k}$. Estimates on the $\mathcal{C}(K)$-distortion of $\Delta_{\leq k}$ will also be given.

The work presented covers joint work with F. Albiac and joint work with D. Freeman, T. Schlumprecht and A. Zsak. (Received August 26, 2013)

1094-46-270 **J. Alejandro Chavez-Dominguez*** (jachavezd@math.utexas.edu), The University of Texas at Austin, Mathematics Dept, RLM 8.100, 2515 Speedway Stop C1200, Austin, TX 78712-1202. *Lipschitz factorization through subsets of Hilbert space.*

The Euclidean distortion of a metric space, a measure of how well it can be embedded into a Hilbert space, has recently been the subject of much interest because of its connections to areas such as computer science and geometric group theory. In this talk we study the corresponding notion for mappings instead of spaces, which is that of Lipschitz factorization through subsets of Hilbert space. The main theorems are two characterizations of when a mapping admits such a factorization, both of them inspired by results dealing with linear factorizations

through Hilbert space. The first is a nonlinear version of the classical Lindenstrauss-Pełczyński theorem in terms of "dominated" sequences of vectors, whereas the second is a duality result by means of a tensor-product approach. (Received August 26, 2013)

1094-46-277 **Jeromy Sivek*** (jsivek@gmail.com), Math Department, 301 Thackeray Hall, Pittsburgh, PA 15260. *Peano and Caratheodory Derivatives in Banach Spaces.*

The Peano derivative, or strong derivative, is a variation of the usual Frechet derivative that localizes the derivative's continuity. Another reformulation of the derivative, due to Caratheodory, is seen to globalize the mean value property. We will see some new results, possibly interesting in their own right, which demonstrate the utility of these definitions. In order to generate these results, we need to prove lemmas clarifying the similarity to the usual definitions. In Asplund spaces we can prove a particularly strong version of one of these lemmas because of Asplund spaces' geometric properties. (Received August 26, 2013)

1094-46-291 **Thomas M. Everest*** (teverest@iup.edu). *Perturbations of Goebel-Kuczumow Sets in ℓ^1 with the Fixed Point Property for Nonexpansive Mappings.*

In 1979 Goebel and Kuczumow introduced a certain class of closed, bounded, convex, non-weak*-compact subsets K of the Banach space ℓ^1 (with its usual norm), and showed that every nonexpansive mapping $T : K \to K$ has a fixed point. In this talk we extend the results of Goebel and Kuczumow by perturbing their sets in various ways, to gain a great variety of closed, bounded, convex, non-weak*-compact subsets K of ℓ^1 for which it is still the case that every nonexpansive mapping $T : K \to K$ has a fixed point. (Received August 26, 2013)

1094-46-304 **John D Jasper*** (jasperj@missouri.edu), 202 Mathematical Sciences Bldg, University of Missouri, Columbia, MO 65211. *Kirkman equiangular tight frames.*

We present a new construction of constant amplitude equiangular tight frames (ETFs), that is, ETFs in which each entry of each frame vector has the same modulus. Our construction builds on the recent work of Fickus, Mixon, and Tremain which uses Steiner systems to construct ETFs, which they have dubbed Steiner ETFs. We show that a Steiner ETF which is constructed using a resolvable Steiner system can be unitarily transformed into a constant amplitude ETF. Since resolvable Steiner systems are sometimes called Kirkman systems, we refer to these as Kirkman ETFs. Several examples are presented, including an infinite class of real Kirkman ETFs. (Received August 26, 2013)

1094-46-309 **Chris Lennard*** (lennard@pitt.edu), Department of Mathematics, University of Pittsburgh, Pittsburgh, PA 15260, **Veysel Nezir**, Community College of Allegheny County, West Mifflin, PA 15122, and **Łukasz Piasecki**, Instytut Matematyki, Uniwersytet Marii Curie-Skłodowskiej, Pl. Marii Curie-Skłodowskiej 1 20-031, Lublin, Poland. *Recent developments in metric fixed point theory.*

We will discuss recent joint work in metric fixed point theory with Veysel Nezir and Łukasz Piasecki, related to cascading nonexpansive mappings and characterizing reflexive Banach spaces. (Received August 26, 2013)

1094-46-326 **Daniel John Fresen*** (daniel.fresen@yale.edu). *Euclidean grid structures in Banach spaces.*

We study how the Euclidean subspaces of a Banach space fit together, somewhat in the spirit of the Kashin decomposition. (Received August 26, 2013)

1094-46-332 **Azita Mayeli*** (amayeli@qcc.cuny.edu), 222-05 56th Ave, Bayside, NY 11364. *Littlewood-Paley decomposition of abstract Besov spaces and applications.* Preliminary report.

Given any abstract Hilbert space and any self-adjoint positive definite operator in the Hilbert space, by the spectral theoretic methods we obtain a Calder'on decomposition for the Hilbert space. Then we apply the result to obtain Littlewood-Paley decomposition of abstract Besov spaces in terms of "Paley-Wiener vectors". To prove this, we use the classical exponential bases methods. We then employ our results to obtain a description of Besov norms for Gelfand pairs associated with the Heisenberg group in terms of band-limited wavelet expansions. (Received August 27, 2013)

1094-46-345 **Gestur Olafsson***, Louisiana State University, Baton Rouge, LA 70803, and **Jens G Christensen**. *Bergman spaces as coorbits.*

We recall the main ideas behind the construction of function spaces using topological groups and representation theory, the coorbit theory. As an example we discuss in details the Bergman spaces on the unit disc and the unit ball in n-dimensional complex space (joint project with Christensen and Grochenig). To simplify the exposition we mainly concentrate on our work with Christensen on the unit disc. (Received August 27, 2013)

1094-46-353 **Sofia Ortega Castillo*** (ortega@math.tamu.edu), Department of Mathematics, Mailstop 3368, Texas A&M University, College Station, TX 77843, and **William B. Johnson** (johnson@math.tamu.edu), Department of Mathematics, Mailstop 3368, Texas A&M University, College Station, TX 77843. *The cluster value problem for Banach spaces.*

We introduce the cluster value problem, and its relation to the Corona problem, in the setting of Banach algebras of holomorphic functions on the open unit ball of a complex Banach space. The main result is that the cluster value problem in separable Banach spaces, for the Banach algebras A_u and H^∞, can be reduced to the cluster value problem in those spaces which are ℓ_1 sums of a sequence of finite dimensional spaces. (Received August 27, 2013)

1094-46-362 **David R Larson*** (larson@math.tamu.edu), Department of Mathematics, Texas A&M University, College Station, TX 77843-3368. *Geometric Dilations in Frame Theory and Operator Theory.* Preliminary report.

We review some recent results of the speaker and collaborators, and discuss some open questions that are related to these results. (Received August 27, 2013)

1094-46-364 **Bunyamin Sari*** (bunyamin@unt.edu), Department of Mathematics, 1155 Union Circle #311430, Denton, TX 76203-5017, and **Konstantinos Tyros**. *The structure of the set of higher order spreading models.*

The partially ordered set with respect to bases domination of the set of the spreading models generated by weakly null sequences in a Banach space have some special semi-lattice like structure. We will discuss extensions of this phenomenon to the higher order spreading models. (Received August 27, 2013)

1094-46-371 **Daniel Freeman*** (dfreema7@slu.edu). *Dilations of Schauder frames for Banach spaces.*

A Schauder frame for a Banach space X is a sequence of pairs $(x_i, f_i)_{i=1}^\infty \subset X \times X^*$ such that $x = \sum f_i(x)x_i$ for all $x \in X$. When studying Parseval frames for Hilbert spaces, it is often useful to dilate them to ortho-normal bases for a larger Hilbert space. We focus on extending this dilation technique to Schauder frames for Banach spaces. That is, given a nice property of a Schauder basis, we are interested in characterizing what Schauder frame property is equivalent to being able to dilate to a Schauder basis with the given basis property.

In particular, we characterize when a Schauder frame may be dilated to a basis for a reflexive Banach space. This talk will cover joint work with Kevin Beanland and Rui Liu. (Received August 27, 2013)

1094-46-381 **Veysel Nezir*** (veyselnezir@yahoo.com), 1939 Seaton st., Pittsburgh, PA 15226. *Exploring fixed point properties for certain c_0-summing basic sequences in c_0.*

In 1981, Maurey proved that every weakly compact, convex subset C of c_0 is such that every nonexpansive (n.e.) mapping $T : C \to C$ has a fixed point; i.e., C has the fixed point property (FPP). Dowling, Lennard, and Turett proved the converse of Maurey's result by showing each closed bounded convex non-weakly compact subset C of c_0 fails FPP for n.e. mappings but in general the mapping failing to have a fixed point is not affine. In 2011, we proved that for certain classes of closed bounded convex non-weakly compact subsets C of c_0, there exists an affine n.e. mapping $T : C \to C$ that fails to have a fixed point. Our result depends on our main theorem: one of the classes consists of those C that are the closed convex hull of an asymptotically isometric (a.i.) c_0-summing basic sequence $(x_i)_{i\in\mathbb{N}}$. As a new result, we show that very large classes of c_0-summing basic sequences turn out to be L-scaled a.i. c_0-summing basic sequences. We let $\eta_n := \gamma_n(b_1e_1 + b_2e_2 + ... + b_ne_n)$, for all $n \in \mathbb{N}$. We find that whenever $0 < b_n$ converges to 1 and $0 < \gamma_n$ converges to 1 and $(\gamma_n)_{n\in\mathbb{N}}$ does not "oscillate too wildly", then we see that the sequence $(\eta_n)_{n\in\mathbb{N}}$ is an L-scaled a.i. c_0-summing basic sequence. (Received August 27, 2013)

47 ► Operator theory

1094-47-5 **Derek Allen Thompson*** (theycallmedt@gmail.com). *Restrictions to Invariant Subspaces of Composition Operators on the Hardy Space of the Disk.*

Invariant subspaces are a natural topic in linear algebra and operator theory. In some rare cases, the restrictions of operators to different invariant subspaces are unitarily equivalent, such as the restrictions of the unilateral shift on $H^2(\mathbb{D})$ to the subspaces z^kH^2. A composition operator with symbol fixing 0 also has these subspaces invariant, and if the symbol is linear fractional and extremally noncompact, the restrictions to these subspaces all have the same norm and spectrum. Despite this evidence, we will use semigroup techniques to show many cases where the restrictions are still not unitarily equivalent. (Received March 13, 2013)

1094-47-50 **J. E. Pascoe*** (jpascoe@math.ucsd.edu), Department of Mathematics, University of California, San Diego (UCSD), 9500 Gilman Drive # 0112, La Jolla, CA 92093-0112. *Operator monotone functions in several variables.*

A function $f : (a, b) \to \mathbb{R}$ is *operator monotone* if $A \leq B$ implies $f(A) \leq f(B)$ for any pair of operators A, B with spectrum contained in (a, b). In 1934, Charles Löwner proved operator monotone functions analytically continue to functions on the upper half plane which themselves map into the upper half plane. We show that there is a similar description of operator monotone functions in several variables.

This is part of a joint work with Ryan Tully-Doyle. (Received August 01, 2013)

1094-47-71 **Matthew McBride*** (mmcbride@math.ou.edu), Norman, OK 73019, and **Slawomir Klimek**. *D-bar Operators in Commutative and Noncommutative Domains.*

Atiyah, Patodi, and Singer, developed a global boundary condition(APS) in the 70's to help extend the index theorem of Dirac operators by showing they had compact inverses. However their condition was restricted to manifolds of certain type. Here we compute the inverse/pseudo inverse to the d-bar operator, $\frac{\partial}{\partial \bar{z}}$ in the classical disk and in the noncommutative disk subject to the APS boundary conditions and show said inverse/pseudo inverse is compact making the boundary problem an elliptic boundary value problem. Even in these two examples they fail to be the type of manifold that is required by the APS theory, hence the necessity to compute it by hand. Moreover no known APS theorem exists in the realm of noncommutative geometry. (Received August 09, 2013)

1094-47-80 **Jingbo Xia** and **Dechao Zheng*** (dechao.zheng@vanderbilt.edu), Department of Mathematics, Vanderbilt University, Nashville, TN 37240. *LOCALIZATION AND BEREZIN TRANSFORM ON THE FOCK SPACE.*

We introduce the class of sufficiently localized operators on the Fock space. This class contains in particular all the Toeplitz operators with bounded symbols. We show that for an operator in the C*-algebra generated by the class of sufficiently localized operators, the operator is compact on the Fock space if and only if its Berezin transform vanishes at infinity. (Received August 11, 2013)

1094-47-87 **A. Aleman**, **K. M. Perfekt**, **S. Richter*** (richter@math.utk.edu) and **C. Sundberg**. *Linear Graph Transformations on spaces of analytic functions.* Preliminary report.

Let $\mathcal{H}$ be a Hilbert space of analytic functions with multiplier algebra $\mathcal{M}(\mathcal{H})$, and let

$$\mathcal{M} = \{(f, T_1 f ...., T_{n-1} f) : f \in \mathcal{D}\}$$

be an invariant graph subspace for $\mathcal{M}(\mathcal{H})^{(n)}$. Here $n \geq 2$, $\mathcal{D} \subseteq \mathcal{H}$ is a vector-subspace, $T_i : \mathcal{D} \to \mathcal{H}$ are linear transformations that commute with each multiplication operator $M_\varphi \in \mathcal{M}(\mathcal{H})$, and $\mathcal{M}$ is closed in $\mathcal{H}^{(n)}$.

We investigate the existence of non-trivial common invariant subspaces of operator algebras of the type

$$\mathcal{A}_\mathcal{M} = \{A \in \mathcal{B}(\mathcal{H}) : A\mathcal{D} \subseteq \mathcal{D} : AT_i f = T_i A f \ \forall f \in \mathcal{D}\}.$$

In particular, for the Bergman space L^2_a we exhibit examples of invariant graph subspaces of fiber dimension 2 such that $\mathcal{A}_\mathcal{M}$ does not have any nontrivial invariant subspaces that are defined by linear relations of the graph transformations for $\mathcal{M}$. (Received August 12, 2013)

1094-47-106 **Akram Aldroubi*** (akram.aldroubi@vanderbilt.edu), Dept of mathematics, Vanderbilt University, SC 1520, Nashville, TN 37240. *Perfect reconstruction of spatially undersampled signals in dynamical systems.*

We present and discuss the dynamical sampling problem: Assume that a function f on a domain D is an initial state of a physical process evolving in time under the action of a family of operators A_t indexed by $t \geq 0$. Can we recover f from the samples $\{f(X), f_{t_1}(X), \ldots, f_{t_N}(X)\}$ of f on $X \subset D$ and its various states $f_t(X) := (A_t f)(X)$ at times $\{t_1, \ldots, t_N\}$? In this talk, we will discuss some of the mathematical issues that arise in this context, and some of the applications. We will present results for some special cases that have been solved with my some of collaborators, Roza Aceska, Jacque Davis, Ilya Krishtal, Armeka Petrosyan, Carlos, Cabrelli and Ursula Molter. (Received August 15, 2013)

1094-47-109 **Pamela Gorkin*** (pgorkin@bucknell.edu), Bucknell University, Department of Mathematics, Lewisburg, PA 17837. *Two classes of Blaschke products and their applications to operator theory.*

We consider the set of thin Blaschke products (a subset of the set of interpolating Blaschke products) and the set of uniform Frostman Blaschke products (a subset of the set of finite products of interpolating Blaschke products). These classes provide information about the range of composition operators on the Hardy space and

the Bergman space, as well as information about multiplication operators. We will discuss ways in which the two classes are similar as well as the connection to operator theory. (Received August 15, 2013)

1094-47-129 **Brett D. Wick*** (wick@math.gatech.edu), School of Mathematics, Georgia Institute of Technology, 686 Cherry Street, Atlanta, GA 30332-0160. *Essential Norm of Operators on Analytic Function Spaces.*

In this talk we will show that the compactness of operators on the Bergman space of the unit ball and the Bargmann-Fock space in several variables can be obtained in terms of the behavior of their Berezin transforms. We show how a vanishing Berezin transform combined with certain (integral) growth conditions on an operator T are sufficient to imply that the operator is compact on the space in question. (Received August 18, 2013)

1094-47-159 **Stephen L Clark*** (sclark@mst.edu), Department of Mathematics and Statistics, Missouri University of Science and Technology, Rolla, MO 65409. *Some Recent Developments in the Study of Discrete Symplectic Systems.*

The spectral theory for discrete symplectic systems has been a subject of recent interest. In this vein, a brief survey is given regarding the study of definiteness for such systems, defect subspaces, and associated maximal and minimal linear relations. (Received August 21, 2013)

1094-47-160 **Marius V Ionescu*** (mionescu@colgate.edu), 13 Oak Dr, Hamilton, NY 13346, and **Alex Kumjian**. *Groupoid actions on fractafolds.*

In this talk that we present how we find and analyze symmetries of fractals associated to iterated function systems $(F_1, \ldots, F_N)$. We study the so called fractafold blowups defined by Strichartz endowed with the inductive limit topology and assemble them into a fractafold bundle L. We describe a natural groupoid action on the fractafold bundle. We show that the resulting action groupoid is a Renault-Deaconu groupoid which is determined by a local homeomorphism on L. The action groupoid is shown to be essentially free and to have a dense orbit. It follows that the associated C^*-algebra is primitive. (Received August 21, 2013)

1094-47-164 **Yohann Le Floch*** (yohann.lefloch@univ-rennes1.fr), Campus de Beaulieu, bâtiments 22 et 23, 263 avenue du Général Leclerc, CS 74205, 35042 Rennes, France. *Spectral theory of Berezin-Toeplitz operators in one degree of freedom.*

Berezin-Toeplitz operators arise in the study of the semiclassical limit of geometric quantization. They act on spaces of holomorphic sections of tensor powers of a complex line bundle over a compact Kähler manifold. Bohr-Sommerfeld conditions relate the spectrum of a self-adjoint Berezin-Toeplitz operator to associated geometric invariants. In their usual form, they give asymptotic expansions of the eigenvalues close to a regular value of the principal symbol of the operator.

After a brief review of geometric quantization and Berezin-Toeplitz operators, we will explain how to derive Bohr-Sommerfeld conditions near non-degenerate singular values of the principal symbol of a self-adjoint Berezin-Toeplitz operator in one degree of freedom. We will emphasize the similarities and differences between the elliptic and hyperbolic cases. (Received August 22, 2013)

1094-47-186 **Wing Suet Li*** (li@math.gatech.edu), School of Mathematics, Georgia Tech, Atlanta, GA 30332-0160. *On the Horn Conjecture (in many settings).*

The Horn Conjecture, the Littlewood-Richardson Rule and its numerous equivalent formulations have been studied extensively by matrix theorists, algebraist, and combinatorists for decades. If one considers the ultimate connection to intersection theory in algebraic geometry, the study would go back to centuries. During the last two decades, we studied these problems from an operator theory point of view, in particular, their analogues in various infinite dimensional settings. In order to deal with the infinite dimensional situation, the techniques that we use are combinatorial (to avoid the lack of an infinite dimensional intersection theory) and taking appropriate limits. Our approach also yields insights into the classical setting. In this talk, I will discuss some of our recent results and some open questions. (Received August 22, 2013)

1094-47-193 **Scott M LaLonde*** (scott.m.lalonde.gr@dartmouth.edu), 6188 Kemeny Hall, Dartmouth College, Hanover, NH 03755. *Groupoid Equivalence and Exactness.* Preliminary report.

We will address the relationship between groupoid equivalence (in the sense of Renault) and exactness for groupoids. In particular, we will discuss how the linking groupoid can be used to show that exactness is preserved under groupoid equivalence. We will end with some possible implications of this result for groupoid C^*-algebras and crossed products. (Received August 23, 2013)

1094-47-237 **Michael Dritschel** (m.a.dritschel@ncl.ac.uk), Department of Mathematics, School of Mathematics and Statistics, University of Newcastle-upon-Tyne, Newcastle-upon-Tyne, NE1 7RU, United Kingdom, **Michael T Jury*** (mjury@ufl.edu), Department of Mathematics, University of Florida, PO Box 118105, Gainesville, FL 32611-1805, and **Scott McCullough** (sam@ufl.edu), Department of Mathematics, University of Florida, PO BOx 118105, Gainesville, FL 32611-8105. *Dilations and constrained algebras.* Preliminary report.

We consider some rational dilation problems for hypo-Dirichlet algebras. Sample results: 1) if S, T are commuting contractive operators on Hilbert space satisfying $S^2 = T^2$, then the pair (S, T) has a commuting unitary dilation (U, V) such that $U^2 = V^2$. 2) However, if instead $S^2 = T^3$, a unitary dilation satisfying $U^2 = V^3$ need not exist. The first theorem may be seen as a limiting case of Agler's rational dilation theorem for the annulus; the counterexample for the second statement shares some features with the counterexample to rational dilation on a two-holed domain, constructed by Dritschel and McCullough. (Received August 26, 2013)

1094-47-356 **Alexander Cloninger** and **Wojciech Czaja*** (wojtek@math.umd.edu), Department of Mathematics, University of Maryland, College Park, MD 20742, and **Timothy Doster**. *Operator-based Data Fusion.* Preliminary report.

The problem of data integration and fusion is a longstanding problem in many fields, ranging from remote sensing to biomedical applications. The goal is to find effective and efficient ways to integrate information from heterogeneous sources to improve outcomes of such applications as, e.g., classification or detection. In this talk we shall present a deterministic approach which exploits fused representations of certain well known data-dependent operators, such as, graph Laplacian and graph Schroedinger operators and their corresponding semigroups. It is through the eigendecomposition of these operators that we introduce the notion of fusion/integration of heterogeneous data. This requires new fusion metrics, joint diffusion embeddings of Coifman and Hirn, approximate inverses of nonlinear dimension reduction techniques, and reductions in computational complexity. This theory can be applied, e.g., to spatial-spectral fusion, or to fusion of hyperspectral satellite imagery (HSI) and LIDAR data. We experimentally verify the results of our methods by utilizing them for the HSI classification problem. (Received August 27, 2013)

49 ► Calculus of variations and optimal control; optimization

1094-49-183 **Radu Balan*** (rvbalan@math.umd.edu), Department of Mathematics, University of Maryland, College Park, MD 20742. *OPTIMAL BEAM PATTERN DESIGN FOR VERY LARGE SENSOR ARRAYS WITH SPARSE SAMPLING.*

The main goal of this work is to adaptively employ a large set of microphone sensors distributed in multiple dimensions to scan an acoustic field. Processing data from a large set of sensors will necessarily involve intelligent definition of suitable subsets of sensors active at various times. This paper presents a novel method for optimal beam pattern design for large scale sensor arrays using convex and non convex optimization techniques to define optimal subsets of sensors capable to select a target location while suppressing a large number of interferences. The first of two optimization techniques we present, uses a LASSO type approach to convexify the corresponding combinatorial optimization problem. The second approach employs simulated annealing to search for optimal solutions with a fixed size subset of active sensors. Our numerical simulations show that for scenarios of practical interest, the convex optimization solution is almost optimal. This is a joint work with Yenming Mark Lai, Heiko Claussen and Justinian Rosca. (Received August 22, 2013)

51 ► Geometry

1094-51-75 **Stavros Garoufalidis** (stavros@math.gatech.edu), **Sergey Norin** (snorin@math.mcgill.ca) and **Thao Vuong*** (tvuong@math.gatech.edu), 686 Cherry ST, Atlanta, GA 30332. *Flag algebras and the stable coefficients of the Jones polynomial.*

We study the structure of the stable coefficients of the Jones polynomial of an alternating link. Explicitly, we identify the first four coefficients with polynomial invariants of a (reduced) Tait graph of the link projection. This motivates us to introduce a polynomial algebra of invariants of planar graphs, prove that it is free, and use a subalgebra of it to construct a plethora of integer-valued invariants of alternating links. We conjecture that all stable coefficients are elements of this algebra, and give experimental evidence for the fifth and sixth stable

coefficient. We illustrate our results tables of all alternating links with at most 10 crossings and all irreducible planar graphs with at most 6 vertices. (Received August 10, 2013)

1094-51-153 **Sean Li*** (seanli@math.uchicago.edu). *Coarse differentiation of Lipschitz maps.*
Bates, Johnson, Lindenstrauss, Preiss, and Schechtman developed a quantitative notion of differentiability for Lipschitz maps between normed linear spaces. We review this result and its application to the Ribe program. (Received August 21, 2013)

1094-51-208 **Shane D'Mello*** (shane@math.sunysb.edu), The Mathematics Department, Stony Brook University, Stony Brook, NY 11794-3651. *Rigid isotopy classification of real rational knots in the 3-sphere.*
The 3-sphere can be realized as a quadric in $\mathbb{RP}^4$ that is defined as the zero set of the homogeneous polynomial $x_1^2 + x_2^2 + x_3^2 + x_4^2 - x_0^2 = 0$. We can then consider knots in the 3-sphere that can be realized as the image of a regular map $k : \mathbb{RP}^1 \to \mathbb{RP}^4$. The additional algebraic structure allows one to define invariants that would not have been possible for classical knots, like the encomplexed writhe number that was defined by Oleg Viro. We will define the rigid isotopy of real rational knots and complete the rigid isotopy classification of all real rational non-singular knots of degrees 6 and less. (Received August 23, 2013)

1094-51-251 **S. J. Dilworth**, **Denka Kutzarova** and **N. Lovasoa Randrianarivony*** (nrandria@slu.edu). *Laakso construction and property* (β).

Laakso graphs are widely recognized in Metric Geometry because of their important properties. For example, they do not bi-Lipschitz embed in a uniform fashion into a rounded ball space ([Laakso], [Tyson]), and conversely a Banach space is superreflexive if and only if the Laakso graphs do not uniformly bi-Lipschitz embed into it ([Johnson, Schechtman]).

Property (β) is a geometric property of Banach spaces that generalizes uniform convexity. We show that having an equivalent norm with property (β) is preserved under uniform quotient mappings between separable Banach spaces. An important ingredient in the proof is a graph we construct in the Laakso fashion. (Received August 26, 2013)

52 ► Convex and discrete geometry

1094-52-49 **Elisabeth M Werner*** (elisabeth.werner@case.edu), **Umut Caglar**, **Matthieu Fradelizi**, **Olivier Guedon**, **Joseph Lehec** and **Carsten Schuett**. *L_p affine surface areas for log concave functions.* Preliminary report.
We give a new proof of a reverse log Sobolev inequality for log concave functions due to Artstein, Klartag, Schuett and Werner. We introduce L_p affine surface areas for log concave functions. (Received August 01, 2013)

1094-52-69 **Pierre YOUSSEF*** (pierre.youssef@univ-mlv.fr), Edmonton, Alberta , Canada. *A short proof for an upper bound of the Banach-Mazur distance to the cube.*
If X, Y are two n-dimensional Banach spaces, the Banach-Mazur distance between X and Y is defined as follows:

$$d(X,Y) = \inf\{\|T\| \cdot \|T^{-1}\| \mid \ T \text{ is an isomorphism between X and Y } \}$$

In a very important result, John proved that for any n-dimensional Banach space X, we have $d(X, l_2^n) \leqslant \sqrt{n}$. A natural question is to estimate the distance between an n-dimensional Banach space and l_∞^n. Bourgain-Szarek'88, Szarek-Talagrand'89 and Giannopoulos'95 studied this problem obtaining respectively $o(n)$, $cn^{\frac{7}{8}}$ and $cn^{\frac{5}{6}}$ (c being of the order of 3). Using a different approach, we provide a short proof of the last result improving the constant involved. The main ingredient is a normalized restricted invertibility principle. Precisely, we prove that the Banach-Mazur distance between an n-dimensional Banach space and l_∞^n does not exceed $(2n)^{\frac{5}{6}}$. (Received August 09, 2013)

1094-52-99 **Alina Stancu*** (alina.stancu@concordia.ca), Department of Mathematics and Statistics, 1455 Blvd de Maisonneuve West, Montreal, Quebec H3G 1M8, Canada. *A class of geometric inequalities for convex bodies.* Preliminary report.
Introduced by Lutwak, the Brunn-Minkowski-Firey theory of convex bodies, also called the L_p theory of convex bodies, gave rise to many new problems in convex geometry some of which generalize classical ones. While for p greater than one, the theory is somewhat well understood, and many problems have been settled, more

questions remain for p between zero and one, or p negative. In this talk, we will focus on a class of L_p geometric inequalities for convex bodies for p between zero and one. (Received August 14, 2013)

1094-52-102 **Umut Caglar*** (umut.caglar@case.edu), Department of Mathematics, Cleveland, OH 44106, and **Elisabeth Werner** (elisabeth.werner@case.edu), Department of Mathematics, Cleveland, OH 44106. *Divergence for s-concave and log concave functions.*

In information theory, probability theory and statistics, an f-divergence is a function that measures the difference between two (probability) distributions. It is a generalization of commonly used divergences such as relative entropy (Kullback-Leibler divergence), Renyi divergences, total variation distance etc. In this talk we introduce f-divergence for s-concave and for log-concave functions. This is based on joined work with E. Werner. (Received August 14, 2013)

1094-52-110 **Deping Ye*** (deping.ye@mun.ca), Department of Mathematics and Statistics, Memorial University of Newfoundland, St. John's, NL A1C 5S7, Canada. *On the monotone properties of general affine surfaces under the Steiner symmetrization.*

Affine surface areas are central in (affine) convex geometry and are fundamental in many problems. They have many nice properties, such as, affine invariance, upper-semicontinuity (or lower-simicontinuity), and valuation. The study of affine surface area went back to Blaschke in 1923. Note that the remarkable Blaschke-Santalo inequality was first discovered and proved by the affine isoperimetric inequality related to the classical affine surface area.

In this talk, I will first introduce the concepts of affine surface areas and then talk about some recent results on affine surface areas, such as the related affine isoperimetric inequalities. In particular, I will focus on the monotone properties of affine surfaces under the Steiner symmetrization. Such properties allow us to prove the affine isoperimetric inequalities without assuming the Blaschke-Santalo inequality. Hence, the centroid condition (required by the Blaschke-Santalo inequality) can be removed (even for non-homogeneous case). (Received August 15, 2013)

1094-52-116 **Christos Saroglou*** (christos.saroglou@gmail.com). *Projection bodies of convex bodies.*

The projection body ΠK of a convex body K in $\mathbb{R}^d$ is defined as the body whose support function in some direction $u \in S^{d-1}$ equals its projection in this direction. We discuss several results on Petty's and Schneider's problems, which ask for the extremal values of the affine invariant $|\Pi K|/|K|^{d-1}$. New and older facts are presented. (Received August 16, 2013)

1094-52-117 **Rick Vitale*** (r.vitale@uconn.edu), Department of Statistics, U-4120, University of Connecticut, Storrs, CT 06269. *Convex bodies: metrics and intrinsic volumes.* Preliminary report.

We consider various metrics for convex bodies with special reference to continuity properties of intrinsic volumes. (Received August 27, 2013)

1094-52-123 **Patrick Kipley Spencer*** (patrick.spencer@mizzou.edu), 202 Mathematical Sciences Bldg, University of Missouri, Columbia, MO 65203. *A note on intersection bodies and Lorentz balls in dimensions greater than 4.*

We show that the unit ball of the n-dimensional Lorentz space $\ln_{w,q}$ is not an intersection body for $q > 2$ and $n \geq 5$. (Received August 17, 2013)

1094-52-132 **Konstantin E. Tikhomirov***, 632 Central Academic Building, University of Alberta, Edmonton, Alberta T6G 2G1, Canada. *The χ-distribution and the randomized Dvoretzky's theorem in l_∞^n.*

Let $\varepsilon \in (0, 1/2)$. We prove that if for some $n > 1$ and $k > 1$, a majority of k-dimensional sections of the ball in l_∞^n is $(1+\varepsilon)$-spherical then necessarily $k \leq C\varepsilon \ln n / \ln \frac{1}{\varepsilon}$, where C is a universal constant. The bound for k is optimal up to the choice of C. (Received August 19, 2013)

1094-52-151 **Galyna V Livshyts*** (glivshyt@kent.edu), 527 Franklin street, Kent, OH 44240. *Maximal surface area of a convex set in $\mathbb{R}^n$ with respect to log concave rotation invariant measures.*

It was shown by K. Ball and F. Nazarov, that the maximal surface area of a convex set in $\mathbb{R}^n$ with respect to the Standard Gaussian measure is of order $n^{\frac{1}{4}}$. We establish the analogous result for all rotation invariant log concave probability measures. We show that the maximal surface area with respect to such measures is of order

$\frac{\sqrt{n}}{\sqrt[4]{Var|X|}\sqrt{\mathbb{E}|X|}}$, where X is a random vector in $\mathbb{R}^n$ distributed with respect to the measure. (Received August 21, 2013)

1094-52-252 **Karoly Bezdek*** (bezdek@math.ucalgary.ca), University of Calgary, 2500 University Drive N.W., Calgary, AB T2N 1N4, Canada. *On spindle starshaped sets.*

Spindle starshaped sets are natural extensions of starshaped sets. We prove analogues of a number of theorems on starshaped sets for spindle starshaped sets, including analogues of Helly's and Krasnosselslky's theorems. This is a joint work with M. Naszodi (Eotvos Univ., Budapest). (Received August 26, 2013)

1094-52-262 **Dmitry Ryabogin*** (ryabogin@math.kent.edu). *On a continuous Rubik's cube.*

Let f and g be two continuous functions on the unit sphere, S^{n-1}, $n \geq 3$, and let their restrictions to any one-dimensional great circle E coincide after some rotation ϕ of this circle: $f(\phi(\theta)) = g(\theta)\ \forall\theta \in E$. We prove that in this case $f = g$ or $f(\theta) = g(-\theta)\forall\theta \in S^{n-1}$. This answers the question posed by Richard Gardner and Vladimir Golubyatnikov. (Received August 26, 2013)

1094-52-268 **M. A. Alfonseca***, maria.alfonseca@ndsu.edu, and **J. Kim**. *On convexity and regularity of intersection bodies.*

We will present several results on the strict improvement of regularity and convexity of convex and star bodies of revolution under the application of the intersection body operator. As a corollary, we prove that in sufficiently high dimension, the double intersection body of a convex body is close to the Euclidean ball in the Banach-Mazur distance. (Received August 26, 2013)

1094-52-325 **V. Yaskin*** (yaskin@ualberta.ca) and **M. Yaskina**. *Thick sections of convex bodies.* Preliminary report.

It is a well-known result that origin-symmetric star bodies are uniquely determined by the areas of their central hyperplane sections. However, it is an open question whether the knowledge of the volumes of "thick sections" (i.e. sections by slabs) is sufficient to determine a body uniquely. We give a positive answer to this question for some particular classes of bodies. (Received August 26, 2013)

1094-52-349 **Jaegil Kim** (jaegil@ualberta.ca), Department of Math & Stat Sciences, University of Alberta, Edmonton, Alberta T6G 2G1, Canada, and **Artem Zvavitch*** (zvavitch@math.kent.edu), The Department of Mathematical Sciences, Kent State University, Kent, OH 44202. *Stability of the reverse Blaschke-Santalo inequality for unconditional convex bodies.*

Mahler's conjecture asks whether the cube is a minimizer for the volume product of a body and its polar in the class of symmetric convex bodies in R^n. The corresponding inequality to the conjecture is sometimes called the the reverse Blaschke-Santaló inequality. The conjecture is known in R^2 and in several special cases. In the class of unconditional convex bodies, Saint Raymond confirmed the conjecture, and Meyer and Reisner, independently, characterized the equality case. In talk we will present a stability version of these results and also show that any symmetric convex body, which is sufficiently close to an unconditional body, satisfies the the reverse Blaschke-Santaló inequality. (Received August 27, 2013)

1094-52-380 **Luis Rademacher*** (lrademac@cse.ohio-state.edu), Dreese Labs 495., 2015 Neil Avenue, Columbus, OH 43210. *The simplex is the only simplicial maximizer of the isotropic constant.*

The isotropic constant L_K is an affine-invariant measure of the spread of a convex body K. For a d-dimensional convex body K, L_K can be defined by $L_K^{2d} = \det(A(K))/(\mathrm{vol}(K))^2$, where $A(K)$ is the covariance matrix of the uniform distribution on K. It is an outstanding open problem to find a tight asymptotic upper bound of the isotropic constant. It has been conjectured that there is a universal constant upper bound. The conjecture is know to be true for several families of bodies, in particular, highly symmetric bodies such as bodies having an unconditional basis. It is also know that maximizers cannot be smooth.

In this work we study the gap between smooth bodies and highly symmetric bodies by showing progress towards reducing to a highly symmetric case among non-smooth bodies. More precisely, we study the set of maximizers among simplicial polytopes and we show that if a simplicial d-polytope K is a maximizer of the isotropic constant among d-dimensional convex bodies, then when K is put in isotropic position it is symmetric around any hyperplane spanned by a $(d-2)$-dimensional face and the origin. By a result of Campi, Colesanti and Gronchi, this implies that the simplex is the only simplicial maximizer of the isotropic constant. (Received August 27, 2013)

53 ► Differential geometry

1094-53-18 **Eckhard Meinrenken*** (mein@math.toronto.edu). *On the Van Est homomorphism for Lie algebroids.*

The Van Est homomorphism for Lie groups is a morphism from the complex of smooth group cochains to the Chevalley-Eilenberg complex. This has been generalized by Weinstein-Xu to the case of Lie groupoids, and even further by Mehta and Abad-Crainic to the simplicial de Rham complex of a Lie groupoid. In this talk, I will explain some geometric aspects of this Van Est map. (Joint work with David Li-Bland) (Received July 05, 2013)

1094-53-92 **J. Xiao*** (jxiao@mun.ca), Department of Mathematics & Statistics, Memorial University, St. John's, NL A1C5S7, Canada. *p-harmonic capacity problem in planar convex ring.* Preliminary report.

This talk will address some geometric properties on the non-negative solutions of p-Laplace equation on a planar convex ring such as: optimal estimates for the area and perimeter of a level set of either p-capacity potential or p-Green function of a bounded convex domain; variational formula and prescription of p-capacity measure attached to p-Green function of the complement of a convex body. (Received August 13, 2013)

1094-53-222 **Rui Loja Fernandes*** (ruiloja@illinois.edu). *Global geometry of non-commutative integrable system.*

The global geometry of classical (commutative) integrable systems on symplectic manifolds, away from singular points, is determined by three distinctive features: the integral affine structure, the monodromy and the Lagrangian Chern class. The purpose of this talk is to describe the global geometry of non-commutative integrable systems on Poisson manifolds, away from singular points. We shall see that these systems exhibit additional remarkable features, besides the usual features that one finds in the symplectic case. (Received August 24, 2013)

1094-53-234 **Songhao Li*** (sli@math.wustl.edu). *Lie algebroid spray.* Preliminary report.

Analogous to the spray in Riemannian geometry, we introduce the Lie algebroid spray, or A-spray. A special case is the Poisson spray as introduced by Crainic and Marcut. As a first application, we show that the source-simply-connected symplectic groupoid of a log symplectic surface is diffeomorphic to the cotangent bundle in such a way that the source map coincide with the bundle projection.

Joint work in progress with Marco Gualtieri. (Received August 25, 2013)

1094-53-294 **Ioan Marcut*** (math@illinois.edu), Urbana, IL 61801. *A rigidity result in Poisson geometry.*

The structure of Poisson manifolds is highly nontrivial even locally. The first difficult result in this direction is Conn's linearization theorem around fixed points.

In my talk I will explain a local rigidity result for Poisson structures that are integrable by a symplectic groupoid whose s-fibers are compact and have trivial second cohomology.

Around fixed points, this result immediately implies Conn's theorem; similarly, around arbitrary symplectic leaves, it can be used to reprove the local normal form theorem. If time permits, I will explain also how this result can be used to compute Poisson-moduli spaces around certain Poisson structures. (Received August 26, 2013)

1094-53-310 **Yanli Song*** (ylsong@me.com), 210 victoria st, Apt 1402, Toronto, ON M5G 1V8, Canada. *Proper moment maps, bordisms, and geometric quantization.*

Let G be a compact connected Lie group acting on a stably-complex manifold M with an equivariant vector bundle. In addition, suppose that ϕ is an equivariant map from M to the Lie algebra of G. We define equivalence relation on the triples (M, E, ϕ) such that the set of equivalence classes forms an abelian group. We will prove that this group is isomorphic to a completion of the character ring R(G). As an application, it provides a geometric proof of the quantization commutes with reduction conjecture in the non-compact setting. (Received August 26, 2013)

54 ► General topology

1094-54-161 **Sarah Martin*** (sarah.dorich@gmail.com), 3222 South 1885 East, Salt Lake City, UT 84106. *Arrow polynomial of periodic virtual knots.*

Virtual knot theory is a generalization of classical knot theory. A periodic link is one with rotational symmetry. Murasugi (1988) proved a simple relationship between the Jones polynomial of a periodic link and the Jones polynomial of its factor link. In virtual knot theory, the Arrow polynomial is an analog of the Jones polynomial. This work extends Murasugi's relationship to the Arrow polynomial for virtual periodic links. (Received August 21, 2013)

1094-54-209 **Aaron Kaestner*** (amkaestner@northpark.edu), 3225 West Foster Avenue, Box 07, Chicago, IL 60625. *Parity Yang-Baxter Cocycle Invariants.* Preliminary report.

We explore extending the Yang-Baxter cocycle invariants for virtual knots by introducing cocycles from a cohomology theory associated to parity biquandle structures. Our extension is modeled on the extension constructed by Ceniceros and Nelson for virtual biquandle structures. These invariants coincide with the classical Yang-Baxter cocycle invariants for classical knots but may provide extra information about virtual knots and links. (Received August 23, 2013)

1094-54-383 **Lena C. Folwaczny*** (lena.folwaczny@gmail.com) and **Louis H. Kauffman**. *Applications of the Wriggle Polynomial and Affine Index Polynomial.*

The Wriggle Polynomial is a virtual knot invariant constructed by assigning a weight at each crossing, the weight being a difference of two virtual linking numbers. The Wriggle Polynomial is equivalent to the Affine Index Polynomial, which is constructed by an integer labeling of arcs in the knot diagram (in the structure of a flat affine biquandle), and then using this integer labeling to assign a weight at each crossing. In this talk we introduce the two polynomials and discuss their ability to distinguish certain types of mutation, their Vassiliev Invariants, and other applications. (Received August 27, 2013)

55 ► Algebraic topology

1094-55-23 **Louis H Kauffman*** (kauffman@uic.edu), Math UIC, 851 South Morgan Street, Chicago, IL 60607-7045. *Invariants of Virtual Knots.* Preliminary report.

This talk will discuss relationships among polynomial invariants of virtual knots, including the arrow polynomial, the affine index polynomial and the Jones polynomial. The aim is to understand when virtual knots undetected by the Jones polynomial can be shown to be non-classical. (Received July 15, 2013)

1094-55-46 **Xuanting Cai** and **Robert G. Todd*** (rtodd@unomaha.edu). *A cellular basis for the generalized Temperly-Lieb Algebra and Mahler Measure.*

We define the n^{th} i-colored Tempelry-Lieb algebra $TL_{(n,i)}$ and construct for it an orthogonal basis, which contains a family of idempotents. We then show that this is a cellular basis as defined by Mathis, and show that there is a family of JM-elements which separate the generalized Temperley-Lieb algebra. We then apply several results on cellular algebras with JM-elements to conclude that the idempotents are primitive, and that the subalgebra generated by the idempotents is the same as that generated by the JM-elements. Furthermore, we define recursive elements of $TL(n,i)$ and show that they are exactly those that lie in the subalgebra generated by the idempotents. These elements are of particular interest as they have been used to related geometric properties of link diagrams to Mahler measure of the Jones and colored Jones polynomials. Lastly we give a slightly improved proof of results of Champanerakar and Kofman that the Mahler measure of the Jones and colored Jones polynomial converge under twisting (Received July 31, 2013)

1094-55-54 **Sam Nelson***, knots@esotericka.org. *Augmented Birack Homology.* Preliminary report.

Augmented biracks are birack structures defined in terms of group actions on sets. In this talk we will see a homology theory for augmented biracks which extends the usual quandle and rack homology in a natural way, enabling enhancements of the counting invariant using 2-cocycles analogously to CJKLS invariants. (Received August 02, 2013)

1094-55-65 **Mustafa Hajij*** (mustafa.hajij@yahoo.com), 4243 Burbank Dr Apt 102, Baton Rouge LA, LA 70808. *Andrews-Gordon identities via the tail of the colored Jones polynomial.* Preliminary report.

The tail of the colored Jones polynomial of an alternating link L, introduced by C. Armond O. Dasbach, is an invariant which takes the form of formal q-series with integer coefficients. We give a skein theoretic method to compute the tail for a large class of knot. Furthermore we use our techniques to prove classical identities in number theory. (Received August 08, 2013)

1094-55-299 **Jing Wang*** (jxfzwangjing@gmail.com) and **Jozef Przytycki**. *Homology of a Small Category with Functor Coefficients: Definitions and Examples.*

In this talk, I will introduce our joint work with Jozef H. Przytycki on homology of a small category with functor coefficients. Our general definition is motivated by homology of an abstract simplicial complex. In particular, for an abstract simplicial complex category, the homology we introduced here can be considered as homology of its barycentric subdivision. As an example, I will show that Khovanov homology can be realized as homology of a small category with coefficients in a functor onto $Z[X]/X^2-$Modules. (Received August 26, 2013)

57 ► Manifolds and cell complexes

1094-57-3 **Efstratia Kalfagianni*** (kalfagia@math.msu.edu), Department of Mathematics, Michigan State University, 619 Red Cedar Road, East Lansing, MI 48824. *Geometric structures and knot invariants.*

It has been known since the 80's that knot complements admit geometric decompositions and that the class of knots with hyperbolic complements is very rich and interesting. Several features and properties of these geometric structures have been revealed and understood trough the study of "essential" embedded surfaces in knot complements. In practice, however, knots are often given in terms of combinatorial topological descriptions, and it is both natural and important to seek for ways to deduce geometric information from these descriptions. On the other hand, in the last couple of decades ideas from physics have led to powerful and subtle knot invariants, such as the Jones knot polynomials, that are also best understood in terms of combinatorial descriptions. Understanding the relation of the combinatorial knot descriptions and invariants to the detailed structures coming from the geometric picture, and in particular to hyperbolic geometry, is a major goal of low dimensional topology that received particular attention in recent years.

In this talk I will survey some conjectured and some established such relations. (Received August 16, 2013)

1094-57-7 **Feng Luo** (fluo@math.rutgers.edu) and **Tian Yang*** (tianyang@math.rutgers.edu). *Hyperbolic cone metrics on 3-manifolds with boundary.*

We prove that a hyperbolic cone metric on an ideally triangulated compact 3-manifold with boundary consisting of surfaces of negative Euler characteristic is determined by its combinatorial curvature. The proof uses a convex extension of the Legendre transformation of the volume function. Several related results on maximum volume semi-angle structures are obtained. (Received August 19, 2013)

1094-57-9 **Chichen M Tsau*** (tsaumc@slu.edu), Department of Mathematics & Computer Science, Saint Louis University, 220 N. Grand Blvd., St. Louis, MO 63103. *On the topology of the coefficients of the Alexander-Conway polynomials.* Preliminary report.

We show that for any knot K, the coefficient a_{2k} of the Alexander - Conway polynomial $\bigtriangledown_K(z) = a_{2n}z^{2n} + ... + a_2z^2 + a_0$ of K, is the sum of the determinants of certain sub-matrices of the Seifert matrix of K, and in particular a_2 represents some self-linking of K. (Received June 05, 2013)

1094-57-24 **Azadeh Rafizadeh*** (rafizadeha@william.jewell.edu). *Using Alexander Polynomials to Detect Fiberedness.*

D.Eisenbud and W.Neumann have developed a theory to determine fiberedness of graph links. We use twisted Alexander polynomials to investigate this problem. Using twisted Alexander polynomials, we prove that the exterior of a particular graph knot is not fibered. Then we build three 2-component graph links containing this knot, and use similar techniques to discuss their fiberedness. (Received July 15, 2013)

1094-57-27 **Anh T Tran*** (tran.350@osu.edu), Department of Mathematics, The Ohio State University, 231 West 18th Avenue, Columbus, OH 43210. *On left-orderable fundamental groups and Dehn surgeries on knots.*

We show that the resulting manifold by r-surgery on a large class of two-bridge knots has left-orderable fundamental group if the slope r satisfies certain conditions. This result gives a supporting evidence to a conjecture of Boyer, Gordon and Watson that relates L-spaces and the left-orderability of their fundamental groups. (Received July 16, 2013)

1094-57-44 **Douglas LaFountain*** (d-lafountain@wiu.edu) and **William Menasco**. *The generalized Jones conjecture for closed braids.*

The generalized Jones conjecture (sometimes referred to as the *braid geography conjecture*) states that all pairs of braid index and algebraic length values realized by closed braids in a link type can be obtained by stabilizing any minimum braid index representative. First posited by Jones in the context of link polynomials, this conjecture was further developed by Kawamuro and has applications to contact topology as well as the study of quasipositive links. In this talk we will discuss the statement, applications and a proof of Jones' conjecture. (Received July 30, 2013)

1094-57-48 **Micah W Chrisman*** (mchrisma@monmouth.edu) and **Vassily O. Manturov**. *Virtual Covers, Fibered Knots, and Virtual Knots.*

We introduce a new technique for studying classical knots with the methods of virtual knot theory. Let K be a knot and J a knot in the complement of K with $\mathrm{lk}(J,K)=0$. Suppose there is covering space $\pi_J : \Sigma \times (0,1) \to \overline{S^3 \backslash V(J)}$, where $V(J)$ is a regular neighborhood of J satisfying $V(J) \cap \mathrm{im}(K) = \emptyset$ and Σ is a connected compact orientable 2-manifold. Let K' be a knot in $\Sigma \times (0,1)$ such that $\pi_J(K') = K$. Then K' stabilizes to a virtual knot $\hat{K}$, called a virtual cover of K relative to J. We investigate what can be said about a classical knot from its virtual covers in the case that J is a fibered knot. Several examples and applications to classical knots are presented. A basic theory of virtual covers is established. The arXiv.org reference for this talk is: arXiv:1307.0538 [math.GT]. (Received August 01, 2013)

1094-57-55 **Stavros Garoufalidis** (stavros@math.gatech.edu), **Craig D. Hodgson** (c.hodgson@ms.unimelb.edu.au), **J. Hyam Rubinstein** (rubin@ms.unimelb.edu.au) and **Henry Segerman*** (henry.segerman@okstate.edu). *Regular triangulations and the index of a cusped hyperbolic 3-manifold.*

Recent work by Dimofte, Gaiotto and Gukov defines the "index" (a collection of Laurent series) associated to an ideal triangulation of an oriented cusped hyperbolic 3-manifold. "Physics tells us" that this index should be a topological invariant of the manifold, not just of the triangulation of it. The problem is that the index is not well defined on all triangulations. We define a class of triangulations of a 3-manifold, depending only on the topology of the manifold, such that the index is well-defined and has the same value for each triangulation in the class. A key requirement is that the class of triangulations be connected by local moves on the triangulations, since we can prove invariance of the index under these moves. To achieve this requirement we import a result from the theory of regular triangulations of Euclidean point configurations due to Gelfand, Kapranov and Zelevinsky. (Received August 03, 2013)

1094-57-62 **Oliver Dasbach** and **Anastasiia Tsvietkova*** (tsvietkova@lsu.edu). *A re fined upper bound for the hyperbolic volume of alternating links and the colored Jones polynomial.* Preliminary report.

Since quantum invariants were introduced into knot theory, there has been a strong interest in relating them to the intrinsic geometry of a link complement. This is reflected, for example, in the Volume Conjecture, which claims that the hyperbolic volume of a link complement in S^3 is determined by the colored Jones polynomial.

In the work of M. Lackenby, and of I. Agol and D. Thurston, an upper bound for volume of a hyperbolic link complement in terms of the number of twists of a link diagram is obtained. We will discuss how to refine this bound for alternating links, and how to express the refined bound in terms of the three first and three last coefficients of the colored Jones polynomial. (Received August 07, 2013)

1094-57-67 **Heather A. Dye*** (hadye@mckendree.edu), 701 College Rd, Lebanon, IL 62254, and **Micah Chrisman**. *The Three Loop Invariant.*

We introduce a finite type invariant of virtual knots, ϕ_{ijk}, called the three loop invariant. The invariant is a Gauss diagram formula where the regions of the diagram are enhanced with the relative index of the arrows. We investigate its properties with respect to geometric symmetries and connected sums. The invariant ϕ_{ijk} is

an analog of the Grishanov-Vassiliev finite type invariant of degree 2. This presentation is on the paper: The Three Loop Isotopy and Framed Isotopy Invariants of Virtual Knots. (Received August 08, 2013)

1094-57-83 **Oliver Dasbach** and **Adam Lowrance*** (adlowrance@vassar.edu). *Khovanov homology of oriented ribbon graphs.*

The all-A ribbon graph of a link diagram is an oriented ribbon graph related to the checkerboard graph of the diagram. We construct Khovanov homology for oriented ribbon graphs and show that the Khovanov homology of the all-A ribbon graph of a link diagram is isomorphic to the Khovanov homology of the link. We extend our results for certain virtual links. (Received August 12, 2013)

1094-57-84 **Wade Bloomquist** (wade-bloomquist@uiowa.edu) and **Charles Frohman*** (charles-frohman@uiowa.edu). *An adapted product to sum formula for the Kauffman Bracket skein module of a punctured torus.*

Let $\Sigma_{g,k}$ denote the compact oriented surface of genus g with k boundary components. The inclusion map $\Sigma_{1,1} \to \Sigma_{1,0}$ induces a homomorphism of the Kauffman bracket skein algebras $K(\Sigma_{1,1}) \to K(\Sigma_{1,0})$ whose kernel is a principle ideal generated by a skein η which is the sum of a link parallel to the boundary and [2] times the empty skein. The mapping splits, so every skein in $K(\Sigma_{1,1})$ can be written $\alpha + \epsilon$ where $\alpha \in K(\Sigma_{1,0})$ and ϵ is the the kernel of the inclusion. We use this decomposition to give a product to sum formula for skeins in $K(\Sigma_{1,1})$ extending the product to sum formula of Frohman and Gelca for $K(\Sigma_{1,0})$. (Received August 12, 2013)

1094-57-85 **Charles Frohman*** (charles-frohman@uiowa.edu) and **Joanna Kania-Bartoszynska** (jkaniab@nsf.gov). *The Kauffman bracket skein module of a connected sum of copies of $S^1 \times S^2$ at roots of unit.*

Let $A = e^{\pi \mathbf{i}/N}$ where N is an odd integer, be the variable in the Kauffman bracket skein relations. We prove that the Kauffman bracket skein module of $\#_k S^1 \times S^2$, of the connected sum of k copies of $S^1 \times S^2$ is the direct sum of two submodules. One is isomorphic to $\mathbb{C}$ and is generated by the empty skein. The other is isomorphic to the $SL_2\mathbb{C}$-characters of the fundamental group of $\#_k S^1 \times S^2$.

The second submodule is used to give a univeral construction of traces on the Kauffman bracket skein module of a surface with boundary at roots of unity. (Received August 12, 2013)

1094-57-100 **Colin Adams*** (cadams@williams.edu), Bronfman Science Center, Williams College, Williamstown, MA 01267, and **Orsola Capovilla-Searle**, **Jesse Freeman**, **Daniel Irvine**, **Samantha Petti**, **Daniel Vitek**, **Ashley Weber** and **Sicong Zhang**. *Multi-crossing Invariants of Knots.*

A multi-crossing is a crossing with n strands of the knot passing straight through it, a classical crossing corresponding to $n = 2$. Every knot has a projection with all n-crossings, so the n-crossing number $c_n(K)$ is well-defined. We determine $c_n(K)$ for many low-crossing knots. We also obtain lower bounds on $c_n(K)$ in terms of the span of the bracket polynomial, generalizing previous results for $n = 2, 3$ and 4. We show $c_n(K)$ is not additive under composition for all $n \geq 4$, and we obtain further results for both the übercrossing number and petal number of knots, which correspond to when there is only a single multi-crossing in the projection. (Received August 14, 2013)

1094-57-103 **Kristen Hendricks*** (hendricks@math.ucla.edu), UCLA Department of Mathematics, 520 Portola Plaza, 6363 Math Sciences Building, Los Angeles, CA 90095. *Localization and the link Floer homology of doubly periodic knots.*

We construct localization spectral sequences for the link Floer homology of doubly-periodic knots, and discuss how they give a simultaneous generalization of two classical results of Kunio Murasugi and Allan Edmonds concerning, respectively, the Alexander polynomial and genus of the knot. (Received August 14, 2013)

1094-57-104 **John Etnyre*** (etnyre@math.gatech.edu) and **Bulent Tosun**. *Surgery constructions of tight contact structures on Seifert fibered spaces.*

We will discuss how to use some extensions of recent work of LaFountain, Tosun and myself on torus knots in the 3 sphere, to classify tight contact structures on some small Seifert fibered spaces. Recall that tight contact structures have been classified on most small Seifert fibered spaces, but there are infinite families that have resisted classification despite many attempts. The approach outlined in this talk results in a classification on infinite subsets of these families and illustrates how studying embeddings of solid tori in contact manifolds can illuminate classification questions. (Received August 14, 2013)

1094-57-112 **Cagri Karakurt**, **Tye Lidman*** (tlid@math.utexas.edu) and **Ciprian Manolescu**. *Floer homology and non-zero degree maps.*

We study the behavior of the Floer homology of rational homology spheres under non-zero degree maps for certain families of maps and spaces. (Received August 16, 2013)

1094-57-124 **Grant S Lakeland*** (lakeland@illinois.edu) and **Christopher J Leininger**. *Systoles and Dehn surgery for hyperbolic 3-manifolds.*

Given a closed hyperbolic 3-manifold M of volume V, and a link $L \subset M$ such that the complement $M \setminus L$ is hyperbolic, we establish a bound for the systole length of $M \setminus L$ in terms of V. This extends a result of Adams and Reid, who showed that in the case that M is not hyperbolic, there is a universal bound of 7.35534... . As part of the proof, we establish a bound for the systole length of a non-compact finite volume hyperbolic manifold which grows asymptotically like $\frac{4}{3} \log V$. This is joint work with Chris Leininger. (Received August 17, 2013)

1094-57-127 **Christopher R Cornwell*** (cornwell@math.duke.edu). *Knot contact homology and representations of the knot group.*

From knot contact homology a three-variable polynomial, called the augmentation polynomial, can be defined. There is a conjectured relationship, similar to the AJ conjecture relating the A-polynomial to colored Jones polynomials, between the augmentation polynomial and the colored HOMFLY-PT polynomials (colored by the symmetric representation).

A specialization of the algebra used in knot contact homology yields a two-variable augmentation polynomial, which is known to have the A-polynomial as a factor. We describe a correspondence between augmentations in this specialization and certain representations of the knot group (KCH representations). The correspondence shows that the two-variable augmentation polynomial may be viewed as a generalized A-polynomial, in that it records the restriction of KCH representations to the peripheral subgroup and 2-dimensional KCH representations give precisely the A-polynomial factor.

As a bonus, the dimension of irreducible KCH representations provides a new method for studying the meridional rank of the knot group and its relationship to the bridge number. (Received August 17, 2013)

1094-57-139 **Tetsuya Ito*** (tetitoh@kurims.kyoto-u.ac.jp), Research Institute for Mathematical Sciences, Kyoto University, Kyoto, 606-8502, Japan, and **Keiko Kawamuro**, Department of Mathematics, The University of Iowa, Iowa City, IA 52240. *Overtwisted disc in planer open book.* Preliminary report.

Using an open book foliation method, we show that an overtwisted disc in a planer open book can be put in a topologically nice position. As a cololary, we give some properties for the monodromy of planer open book supporting an overtwisted contact structure. In particular, we give a tightness criterion based on the FDTC (fractional Dehn twist coefficient). (Received August 19, 2013)

1094-57-143 **Sergio R Fenley*** (fenley@math.fsu.edu), Department of Mathematics, Tallahassee, FL 32306-4510, and **Thierry Barbot** (thierry.barbot@univ-avignon.fr), Universite d'Avignon et des pays de Vaucluse, 84000 Avignon, France. *Structure and rigidity of totally periodic pseudo-Anosov flows in graph manifolds.* Preliminary report.

A graph manifold is an irreducible manifold so that all pieces of the torus decomposition are Seifert fibered. We consider pseudo-Anosov flows in graph manifolds so that all pieces are periodic. This means that a regular fiber is freely homotopic to a closed orbit of the flow. We show that these flows are rigid, that is, they are completely determined up to topological conjugacy by the dynamics and the topological structure of a finite collection of dynamical spines associated to the flow. Each spine is made up of finitely many Birkhoff annuli which contain all dynamical information in the particular Seifert piece of the torus decomposition. (Received August 20, 2013)

1094-57-162 **Patrick M. Gilmer*** (gilmer@math.lsu.edu) and **Stepan Yu Orevkov**. *Signatures of real algebraic curves via plumbing diagrams.* Preliminary report.

Let Q denote S^3 modulo the quaternion 8-group. The first author associated a link $L(C)$ in Q to a real algebraic curve C (equipped with a complex orientation) in the real projective plane. We give a graph link description of $L(C)$ inside a plumbing description of Q which is adapted to C. This is used to compute signature and nullity invariants of $L(C)$ that are associated to odd-prime-fold branched covers of Q along $L(C)$. (Received August 21, 2013)

1094-57-167 **THANG LE*** (letu@math.gatech.edu). *Growth of homology in finite abelian coverings.*
We will discuss the growth of (i) the torsion of homology groups and (ii) the regulator, which measures the volume of the free part of the homology group, in finite abelian coverings of a finite CW-complex. (Received August 21, 2013)

1094-57-171 **Jozef H. Przytycki*** (przytyck@gwu.edu), Department of Mathematics, George Washington University, Washington, DC 20052, and **Witold Rosicki**. *Cycle invariants of codimension 2-embeddings $f : M^n \to R^{n+2}$.*
For any quandle $(X; *)$ we construct $(n + 1)$- and $(n + 2)$-cycle invariants of M^n in R^{n+2} using colorings and shadow colorings of (R^{n+1}, D_M) where D_M is a diagram of a knotting $f : M^n \to R^{n+2}$. Our construction is based on work of Scott Carter, Roger Fenn, Seiichi Kamada, Colin Rourke, Masahico Saito, and Brian Sanderson. (Received August 22, 2013)

1094-57-194 **Marc Lackenby** and **Jessica S Purcell*** (jpurcell@math.byu.edu). *Cusp volumes of alternating knots.*
We show that the cusp volume of a hyperbolic alternating knot can be bounded above and below in terms of the twist number of an alternating diagram of the knot. This answers a question of Thistlethwaite, and gives evidence for a stronger conjecture of Thistlethwaite. In addition to giving diagrammatical estimates on cusp volume, the result also leads to geometric estimates on lengths of slopes, in terms of a diagram of the knot. All these estimates are explicit. This is joint work with Marc Lackenby. (Received August 23, 2013)

1094-57-200 **Michael Freedman** and **Slava Krushkal***, krushkal@virginia.edu. *Distortion and thickness of complexes in Euclidean space.*
Recent developments in the study of thickness and distortion of complexes embedded in Euclidean spaces will be reviewed: knots and graphs in 3-space, as well as in higher dimensions. Families of 2-complexes K will be introduced whose embedding thickness in 4-space is qualitatively different from the previously observed phenomena in the subject. Their higher-dimensional analogues will also be discussed. (Received August 23, 2013)

1094-57-207 **Eriko Hironaka*** (hironaka@math.fsu.edu), Florida State University, Department of Mathematics, Tallahassee, FL 32306-4510. *Towards a fibered face theory for free-by-cyclic groups.* Preliminary report.
Thurston's theory of fibered faces gives a way of partitioning the set of pseudo-Anosov mapping classes into families with related dynamics using foliations of fibered hyperbolic 3-manifolds. S. Dowdall, I. Kapovich, and C. Leininger similarly partition fully-irreducible, aperiodic free group automorphisms into families corresponding to integral points on open (DKL) cones in Euclidean space using properties of branched surfaces associated to free-by-cyclic groups. In this talk, we describe joint work with Y. Agom-Kfir and K. Rafi, on a "fibered face theory" for directed graphs or "digraphs" expanding on results of C. McMullen. We use it to define a polynomial invariant for DKL cones that is analogous to the McMullen polynomial for fibered cones of hyperbolic 3-manifolds. Dowdall, Kapovich, and Leininger have independently defined a polynomial invariant for DKL cones with similar properties. (Received August 24, 2013)

1094-57-213 **J. Scott Carter** and **Seung Yeop Yang*** (syyang@gwmail.gwu.edu), 1019 21st Street South, Arlington, VA 22202. *Twist Spinning Knotted Trivalent Graphs.*
In 1965, E. C. Zeeman proved that the $\pm$1-twist spin of any knot $K \subset S^{n-1}$ is unknotted in S^n . In 1991, Y. Marumoto and Y. Nakanishi gave an alternate proof of Zeeman's theorem by using the moving picture method. In this talk, we define a knotted 2-dimensional foam which is a generalization of a knotted sphere and prove that a $\pm$1-twist spin of a knotted trivalent graph is not always unknotted. We then see families of knotted graphs for which $\pm$1-twist spinning are always unknotted. We work in the smooth (or piecewise linear) category throughout this talk. (Received August 23, 2013)

1094-57-214 **Keiko Kawamuro*** (kawamuro@iowa.uiowa.edu), 14 MacLean Hall, Iowa City, 52242, and **Tetsuya Ito**. *The self-linking number of transverse links and sharpness of Bennequin-Eliashberg inequality.* Preliminary report.
I present a braid-theoretic formula of the self-linking number of transverse links in general contact manifolds. The formula generalizes the Bennequin's formula for the standard contact 3-sphere. Then I discuss sharpness of the celebrated Bennequin-Eliashberg inequality that is used to detect tightness of a given contact structure. (Received August 23, 2013)

1094-57-225 **Adam J. Giambrone*** (giambro1@msu.edu). *Combinatorics of Link Diagrams and Volume Estimates.* Preliminary report.

In this talk, we will begin with a study of the combinatorics of A-adequate link diagrams whose associated all-A state graphs satisfy a certain two-edge loop condition. From this, we obtain a lower bound on the complexity of the all-A graph. By work of Futer, Kalfagianni, and Purcell, such links are usually hyperbolic and the complexity bound actually provides a lower bound on the volume of the link complement. This pairs nicely with work of Agol and D. Thurston to give two-sided bounds in terms of the twist number of the diagram. Finally, we express these bounds in terms of stable coefficients of the colored Jones polynomial. (Received August 24, 2013)

1094-57-226 **Carmen Caprau***, 5245 N. Backer Avenue M/S PB 108, Fresno, CA 93740. *Yang-Baxter state models and singular links.* Preliminary report.

We consider the Yang-Baxter state model for the sl(n) polynomial (introduced by L. Kauffman) and extend it to a polynomial invariant for singular links. We also discuss our efforts in extending these state models to invariants for 4-valent knotted graphs. (Received August 25, 2013)

1094-57-232 **John A Baldwin*** (john.baldwin@bc.edu) and **Steven Sivek**. *A contact invariant in sutured monopole homology and Lagrangian concordance.* Preliminary report.

I'll describe a contact invariant for manifolds with boundary defined using Kronheimer-Mrowka's sutured monopole homology theory. Our construction leads to new interpretations of Honda-Kazez-Matic's contact invariant in sutured Floer homology and of Honda's bypass exact triangle, and provides a new (and computable) obstruction to the existence of Lagrangian concordances between Legendrian knots. This is joint work with Steven Sivek. (Received August 25, 2013)

1094-57-257 **Neal W Stoltzfus*** (stoltz@lsu.edu), Dept Maths, LSU, Baton Rouge, LA 70803. *Ribbon Graph Constructions with Applications to Link Invariants.* Preliminary report.

Constructions in the theory of link diagrams: tangle insertions, mutations, parallels, can be studied from the perspective of Jones-Singerman operations on ribbon graphs. Associated formulae for the rank polynomials are developed & the corresponding properties given for link invariants. (Received August 26, 2013)

1094-57-293 **Steven Frankel*** (steven.frankel@yale.edu). *Quasigeodesic flows and pseudo-Anosov dynamics.*

A flow is called quasigeodesic if each flowline is uniformly efficient at measuring distances on the large scale. We'll discuss quasigeodesic flows on closed hyperbolic 3-manifolds "from infinity." In particular, we'll see that quasigeodesic flows have pseudo-Anosov dynamics at infinity. Along the way we'll show that quasigeodesic flows give rise to group-invariant sphere-filling curves, generalizing the Cannon-Thurston construction for suspension flows. (Received August 26, 2013)

1094-57-301 **Cody Armond*** (cody-armond@uiowa.edu), Department of Mathematics, 14 Maclean Hall, Iowa City, IA 52242. *The Multiple Tails of Torus Knots.* Preliminary report.

The colored Jones polynomial is a sequence of Laurent polynomial link invariants. It has previously been shown that for alternating links and adequate links, the sequence of leading coefficients stabilize which produces a power series called the tail of the colored Jones polynomial. Examples where this fails are easy to find, and in the particular example of torus knots, the sequence of leading coefficients alternate between two tails. This phenomenon was seen by using a known formula for the colored Jones polynomial of torus knots. In this talk I will describe an alternate, more enlightening, proof using the q-holonomicity property, which will potentially be applicable to larger classes of knots. (Received August 26, 2013)

1094-57-311 **Stefan Friedl** (sfriedl@gmail.com) and **Daniel S Silver*** (silver@southalabama.edu), Department of Mathematics and Statistics, ILB, Mobile, AL 36688, and **Susan G Williams** (swilliam@southalabama.edu). *Splittings of Knot Groups.*

Let K be a knot of genus g. If K is fibered, then it is well known that the knot group $\pi(K)$ splits only over a free group of rank $2g$. We show that if K is not fibered, then $\pi(K)$ splits over non-free groups of arbitrarily large rank. Furthermore, if K is not fibered, then $\pi(K)$ splits over every free group of rank at least $2g$. However, $\pi(K)$ cannot split over a group of rank less than $2g$. The last statement is proved using the recent results of Agol, Przytycki–Wise and Wise. (Received August 26, 2013)

1094-57-313 **Heather M. Russell*** (hrussell2@washcoll.edu). *Oriented skein modules and the Frohman-Gelca formula.*

Using an oriented skein module of curves in thickened surfaces, we offer an alternative proof of the product-to-sum result of Frohman and Gelca that relates the Kauffman bracket skein module of the cylinder over the torus to a certain canonical subalgebra of the non-commutative torus. This project is ongoing joint work with Hoel Queffelec at Universite Paris VII. (Received August 26, 2013)

1094-57-317 **Heather M. Russell*** (hrussell2@washcoll.edu). *sl4 web combinatorics.* Preliminary report.

Quantum knot invariants come from interpreting knot diagrams as pictures of intertwiners of quantum group representations. Each knot can be decomposed as a linear combination of certain basic planar trivalent graphs called webs. We discuss some combinatorial results about sl4 webs obtained during the Summer 2012 CSU Channel Islands REU. This work is joint with Ernest Guico, Jennifer Kenkel, Acadia Larsen, Briseida Trejo-Escamilla, and Madison Turbeville. (Received August 26, 2013)

1094-57-318 **J. Scott Carter**, **Daniel S. Silver** and **Susan G. Williams*** (swilliam@southalabama.edu), Department of Mathematics and Statistics, ILB 325, University of South Alabama, Mobile, AL 36688. *Invariants of links in thickened surfaces.*

We define a group invariant for links in thickened surfaces, the covering group, and a related polynomial invariant. These invariants generalize the link group and Alexander polynomial of a link in the 3-sphere. The covering group admits a natural action by the group of the surface.

A virtual link is an equivalence class of links in thickened surfaces, allowing addition and deletion of hollow 1-handles. Its virtual genus is the minimal genus of a supporting thickened surface. We show that the virtual genus is determined by the covering group of any representative of the class. Further, we give a readily computable lower bound for virtual genus derived from our polynomial invariant. (Received August 26, 2013)

1094-57-322 **Mark Brittenham*** (mbrittenham2@math.unl.edu), Department of Mathematics, 203 Avery Hall, University of Nebraska, Lincoln, NE 68588-0130. *Seifert surfaces and sutured manifolds.* Preliminary report.

A Seifert surface Σ for a knot K which has smallest possible genus is the leaf of a finite depth foliation of the knot exterior. Depth serves as a measure of how complicated (the complement of) Σ is. We report on investigations of disk decomposability and depth of minimal genus Seifert surfaces, especially in the case when the knot K has more than one such Seifert surface. (Received August 26, 2013)

1094-57-328 **Helen M Wong*** (hwong@carleton.edu), 1 N College St, Northfield, MN 55057, and **Francis Bonahon**, 3620 S. Vermont Avenue, Los Angeles, CA 90089. *Constructing representations of the Kauffman skein algebra.*

We describe a construction for representations of the Kauffman skein algebra of a surface at certain roots of unity. We utilize a trace map from the skein algebra to the quantum Teichmuller space. Our method is straightforward for the punctured surface but is more intricate for the closed case. (Received August 27, 2013)

1094-57-335 **John A. Baldwin**, **J. Elisenda Grigsby*** (grigsbyj@bc.edu) and **Stephan M. Wehrli**. *Khovanov homology and trivial braid detection.*

I will describe how to use Khovanov homology to detect the trivial braid. The proof is completely combinatorial, relying on an interesting connection between Plamenevskaya's invariant of transverse links and Dehornoy's strict, total order on the braid group. Portions of this talk are joint with John Baldwin, and other portions are joint with Stephan Wehrli. (Received August 27, 2013)

1094-57-339 **Christopher W Davis** and **Arunima Ray*** (arunima.ray@rice.edu), Department of Mathematics, Rice University, MS-136, 6100 Main St., PO Box 1892, Houston, TX 77251-1892. *Satellite operators as group actions on knot concordance.*

Any knot in a solid torus (called a satellite operator) acts on knots in 3-space. We introduce a generalization of satellite operators which act on knots in homology 3-spheres. Unlike traditional satellite operators, these generalized operators form a group, modulo an appropriate generalization of concordance. By studying the action of this group on knots in homology 3-spheres we recover the very recent result of Cochran-Davis-Ray that satellite operators with strong winding number one give injective functions on smooth knot concordance in S^3 x [0,1], modulo the smooth 4-dimensional Poincare Conjecture. We also describe how the notion of generalized satellite operators provides a new framework within which to consider the question of surjectivity of satellite

operators and make some progress towards answering this question. We also construct a new example of a bijective satellite operator. (Received August 27, 2013)

1094-57-340 **Arunima Ray*** (arunima.ray@rice.edu), Department of Mathematics, Rice University, MS-136, 6100 Main St., PO Box 1892, Houston, TX 77251-1892. *Casson towers and filtrations of the smooth knot concordance group.*

A knot is slice, i.e. trivial in the (smooth) knot concordance group, if it bounds an embedded disk in 4–space. Therefore, one may obtain interesting subgroups of the knot concordance group by considering knots which bound more general objects such as immersed disks. By considering knots which bound Casson towers – a generalization of immersed disks – we find a geometric analog for the positive and negative filtrations of knot concordance given by Cochran-Harvey-Horn. This is particularly motivated by the goal of filtering smooth concordance classes of topologically slice knots. We also show how our Casson tower filtration is related to the grope filtration and n-solvable filtration of the smooth knot concordance group. (Received August 27, 2013)

1094-57-347 **Jeffrey Boerner*** (boernerj@uwstout.edu), University of Wisconsin-Stout, Menomonie, WI 54751. *The $sl(3)$ skein module of the solid torus.* Preliminary report.

Mikhail Khovanov defined $sl(3)$ link homology in terms of relations on surfaces. The $sl(3)$ skein module is based on these relations. Heather Russell completely determined the Bar-Natan skein module of the solid torus with $2n$ parallel boundary curves. We would like to accomplish something similar to what Russell did, but for the $sl(3)$ skein module. This talk will define the skein module, provide examples and demonstrate difficulties encountered in exploring the $sl(3)$ skein module of the solid torus. (Received August 27, 2013)

1094-57-351 **Charles D. Frohman** and **Joanna Kania-Bartoszynska*** (jkaniaba@nsf.gov), Division of Mathematical Sciences, National Science Foundation, 4201 Wilson Blvd., Room 1025, Arlington, VA 22230. *Example of an Extended Topological Quantum Field Theory.*

We give a skein theoretic description of an extended Topological Quantum Field Theory that underlies the Witten-Reshetikhin-Turaev invariants of 3-manifolds. (Received August 27, 2013)

1094-57-358 **Karene Ka Yin Chu*** (chukare@mit.edu), Department of Mathematics, M.I.T., 77 Massachusetts Avenue, Cambridge, MA 02139. *On Flat Virtual Pure Tangles.*

Virtual knot theory, introduced by Kauffman, is a generalization of classical knot theory of interest because its finite-type invariant theory is potentially a topological interpretation of Etingof and Kazhdan's theory of quantization of Lie bialgebras. Classical knots inject into virtual knots, and flat virtual knots is the quotient of virtual knots which equates the real positive and negative crossings, and in this sense is complementary to classical knot theory within virtual knot theory.

We classify flat virtual tangles with no closed components and give bases for its "infinitesimal" algebras. The classification of the former can be used as an invariant on virtual tangles with no closed components and virtual braids. We will also show that the infinitesimal algebras are the target spaces of any universal finite-type invariants on the respective variants of the flat virtual tangles. (Received August 27, 2013)

1094-57-374 **Jeremy Van Horn-Morris*** (jvhm@uark.edu), Department of Mathematical Sciences, 301 SCEN, 1 University of Arkansas, Fayetteville, AR 72701, and **Inanc Baykur**, Lederle Graduate Research Tower, University of Massachusetts, Amherst, MA 01003. *Positive factorizations and symplectic fillings.*

We'll discuss a recent construction of families of Stein fillings of fixed contact 3-manifolds which (as a family) have unbounded Euler characteristic (and hence unbounded b_2). The equivalence between Stein manifolds and Lefschetz fibrations allows us to interpret the question in terms of factorizations of surface diffeomorphisms (on a surface with boundary) into right-handed Dehn twists and so we give a family of diffeomorphisms, each having arbitrarily long positive factorizations. (Received August 27, 2013)

1094-57-376 **Alan F. Diaz***, 5861 Pine Road, Doraville, GA 30340. *Plamenevskaya's transverse invariant and the self-linking number.*

In 2004, Plamenevskaya defined an invariant ψ of a transverse link T that consists of a distinguished class in the Khovanov homology of the smooth link type of T, and which encodes the self-linking number, a classical invariant. Later, Baldwin and Plamenevskaya showed using Heegaard Floer theory that this invariant can be used to detect tight contact structures on the branched double covers of some links. However, it was not known whether $\psi(T)$ was a strictly stronger invariant of transverse links than the self-linking number, though Lipshitz, Ng and Sarkar gave evidence earlier this year that it was not. I will show that $\psi(T)$ is in fact determined by the smooth link type and self-linking number. (Received August 27, 2013)

1094-57-378 **Hyunshik Shin*** (hshin@math.gatech.edu). *Pseudo-Anosov mapping classes with dilatation of degree 2g.*

Thurston proved that for a closed surface of genus g, the algebraic degree of a pseudo-Anosov dilatation is bounded above by 6g-6. However, little is known about which degrees occur. In this talk we will describe a construction of pseudo-Anosov homeomorphisms with degree equal to 2g. (Received August 27, 2013)

1094-57-389 **David Gabai** and **Maria Trnkova*** (m.d.trnkova@gmail.com), Mathematics 253-37, Caltech, 1200 East California Blvd, Pasadena, CA 91106. *Exceptional hyperbolic 3-manifolds.*

We correct and complete a conjecture of D. Gabai, R. Meyerhoff and N. Thurston on the classi cation and properties of thin tubed closed hyperbolic 3-manifolds. We additionally show that if N is a closed hyperbolic 3-manifold, then either N = Vol3 or N contains a closed geodesic that is the core of an embedded tube of radius log(3)/2. (Received August 27, 2013)

1094-57-395 **Patricia Cahn*** (pcahn@math.upenn.edu) and **Asa Levi**. *Vassiliev Invariants of Virtual Legendrian Knots.*

We introduce a theory of virtual Legendrian knots. A virtual Legendrian knot is a cooriented wavefront on an oriented surface up to Legendrian isotopy of its lift to the unit cotangent bundle and stabilization and destablization of the surface away from the wavefront. We show that the groups of Vassiliev invariants of virtual Legendrian knots and of virtual framed knots are isomorphic. In particular, Vassiliev invariants cannot be used to distinguish virtual Legendrian knots that are isotopic as virtual framed knots and have equal virtual Maslov numbers. (Received August 27, 2013)

58 ► Global analysis, analysis on manifolds

1094-58-17 **Ruth Gornet*** (rgornet@uta.edu) and **Ken Richardson** (k.richardson@tcu.edu). *The Eta Invariant on Two-Step Nilmanifolds.*

The eta invariant appears regularly in index theorems but is known to be computable only in certain examples of locally symmetric spaces of compact type. In this work, we derive some general formulas useful for calculating the eta invariant on closed manifolds. For general Heisenberg three-manifolds, the spectrum of the spinc Dirac operator and the eta invariant are computed in terms of the metric, lattice, and spin structure data. There are continuous families of geometrically, spectrally different Heisenberg three-manifolds whose Dirac operators have constant eta invariant. We also show that the Dirac spectrum is symmetric about zero in Heisenberg manifolds of dimension 4m+1, thus, the eta invariant is automatically zero in these dimensions. (Received July 02, 2013)

1094-58-52 **Markus J. Pflaum*** (markus.pflaum@colorado.edu), Department of Mathematics, University of Colorado UCB 395, Boulder, CO 80305, and **Hessel Posthuma** and **Xiang Tang**. *The transverse index theorem for proper cocompact actions of Lie groupoids.*

In the talk, we consider a proper cocompact action of a Lie groupoid and define a higher index pairing between invariant elliptic differential operators and smooth groupoid cohomology classes. We prove a cohomological index formula for this pairing by applying the van Est map and algebraic index theory. The meaning of the index pairing and our index formula is also discussed by considering examples. (Received August 02, 2013)

1094-58-393 **Nigel Higson*** (higson@math.psu.edu), Department of Mathematics, Penn State University, University Park, PA 16802. *Another look at the analytic solution of the quantization commutes with reduction problem.* Preliminary report.

The quantization commutes with reduction phenomenon was first explored by Guillemin and Sternberg within the context of Kahler geometry. A great deal has been written on the topic since then, often with the goal (successfully achieved) of broadening the context to symplectic geometry or beyond. But I want to return to the Kahler context and examine there the remarkable analytic proof of Tian and Zhang of the general quantization commutes with reduction theorem in symplectic geometry. The general argument simplifies considerably in the Kahler case. I hope this observation will help make clearer the power and elegance of the Tian-Zhang approach. It might also offer clues to help find analytic proofs quantization commutes with reduction theorems in other contexts. (Received August 27, 2013)

60 ► Probability theory and stochastic processes

1094-60-246 **Timothy Chumley*** (tchumley@iastate.edu). *Random billiards and diffusivity in multiple scattering systems.*

We present a class of random dynamical systems derived from particle-surface systems involving classical scattering and certain random walks derived from them. Of particular interest is the connection between surface microstructure and diffusion characteristics of the derived random walks. (Received August 25, 2013)

1094-60-247 **Nevena Maric*** (maric@math.umsl.edu), MO. *Fleming-Viot particle system driven by a random walk on naturals.*

Random walk on naturals with negative drift and absorption at 0, when conditioned on survival, has uncountably many invariant measures (quasi-stationary distributions, qsd). We study a Fleming-Viot (FV) particle system driven by this process. In this particle system there are N particles where each particle evolves as the random walk described above. As soon as one particle is absorbed, it reappears, choosing a new position according to the empirical measure at that time. Between the absorptions, the particles move independently of each other. Our focus is in the relation of empirical measure of the FV process with qsds of the random walk. Firstly, mean normalized densities of the FV unique stationary measure converge to the minimal qsd, as N goes to infinity. Moreover, every other qsd of the random walk corresponds to a metastable state of the FV particle system. (Received August 25, 2013)

1094-60-303 **Benoit Collins** and **Alexander E. Litvak*** (aelitvak@gmail.com), Dept. of Math. and Stat. Sciences, University of Alberta, Edmonton, AB T6G 2G1, Canada, and **Piotr Gawron** and **Karol Zyczkowski**. *Numerical range of random matrices.* Preliminary report.

The numerical range of random matrices

Given square complex random matrix A its numerical range is defined as $W(A) = \{(x, Ax) : |x| = 1)\}$. We show that the numerical range of the Ginibre $n \times n$ matrix (i.e., the matrix with i.i.d. centered Gaussian complex random variables of variance $1/n$) converges to the disk of radius $\sqrt{2}$. We discuss other ensembles as well. (Received August 26, 2013)

1094-60-334 **Umit Islak*** (islak@usc.edu), Department of Mathematics, USC, 3620 S Vermont Ave, Los Angeles, CA 90089-2532, and **Larry Goldstein**. *Concentration of measure inequalities via bounded couplings.*

Let Y be a mean zero random variable with finite positive variance σ^2 and with finite moment generating function. In this study, we prove concentration of measure inequalities for Y that allow bounded zero biased couplings. An application of our results is provided for the Hoeffding statistic when the random permutation is uniform over the symmetric group. (Received August 27, 2013)

1094-60-342 **Mauro Maggioni*** (mauro@math.duke.edu), BOX 90320, Department of Mathematics, Duke University, Durham, NC 27708. *Geometric Multi-Resolution Analysis and Approximation of probability measures in high dimensions.*

Given n i.i.d. samples from a probability measure μ in $\mathbb{R}^D$, we study the problem of constructing efficiently an approximation $\hat{\mu}_n$ that is close to μ in a Wasserstein metric. The approximation scheme we propose is suited for the situation when μ is concentrated near a locally-linear low-dimensional set. This is motivated by the analysis of large data sets in high-dimensions, which in many applications appear to have low intrinsic dimension. Our construction is baed on a hierarchical multi-resolution analysis on the data, where at each level of a hierarchy an approximation to μ is constructed, and is suitably refined at finer scales depending on the number of samples available and on the complexity of μ. The approximation guarantees are, under suitable assumptions on μ, independent of the ambient dimension, are non-asymptotic, and show that with high probability we obtain an estimator $\hat{\mu}_n$ of μ that approximates μ suitably rapidly in n. Fast algorithms implement this construction and applications will be demonstrated to real world data sets. (Received August 27, 2013)

62 ► Statistics

1094-62-281 **Carla Passini*** (passica@quincy.edu), Quincy University, 1800 College Ave., Quincy, IL 62301, and **Ping Ye** (yepi@quincy.edu), Mathematics Department, Quincy University, 1800 College Ave., Quincy, IL 62301. *Sabermetrics: The Past, the Present, and the Future.*

This paper highlights the growing mathematical concept of sabermetrics. The focus of this paper looks at the past, present, and future of sabermetrics in athletics especially in baseball games. It overviews the traditional measures for evaluating players, analyzes the current measures that have been developed, and previews the new evaluation methods based on groundbreaking types of data collection. More specifically, it illustrates the methods to use sabermetrics to collect and summarize data to evaluate the performance of batters, pitchers, and fielders. Sabermetrics allows sports to be viewed in an innovative arena with hundreds of newfangled statistics that will rate players more accurately, certainly affecting the compensation and altering how the game itself is played. (Received August 26, 2013)

65 ► Numerical analysis

1094-65-386 **Nuray Bozkaya Oktem*** (nbozkaya@yahoo.com), Department of Mathematics, Canakkale Onsekiz Mart University, Campus Terzioglu, 17020 Canakkale, Turkey. *Boundary element analysis of magnetohydrodynamic pipe flow considering the pipe wall thickness.*

The fully developed magnetohydrodynamic(MHD) flow equations through a pipe with arbitrary wall conductivities under the influence of an externally applied magnetic field is studied numerically. An external magnetic field is assumed to be applied either transversely or oriented to the direction of the flow and the flow is driven by the current which is produced by a pressure gradient. A direct boundary element method (BEM) approach is developed for the solution of the problem by first deriving the fundamental solution of the coupled system of full MHD equations in terms of velocity and magnetic field. In applications, the thickness of the pipe is not ignored, thus, it is possible to solve the MHD pipe flow problems within the most general wall conductivities in two solution domains: the interior of the pipe occupied by the fluid and the pipe itself occupied by the walls. The numerical simulations are carried out for different values of Hartmann number and the results are shown graphically in terms of equivelocity and magnetic field contours. (Received August 27, 2013)

68 ► Computer science

1094-68-156 **Elham S. Khorasani*** (esahe2@uis.edu), The Department of Computer Science, The university of Illinois at Springfield, One University Plaza, Springfield, IL 62703. *Formalization and Implementation of Computing with Words.*

The way humans deal with a huge amount of information in their environment is fundamentally different from how computers process this information. While computers constantly require precise numeric inputs to operate, humans have a remarkable ability to perform complex everyday tasks and make intelligent decisions in an inherently vague and imprecise environment without any measurements or precise computations. Inspired by this human singular ability, Computing with Words (CW) is introduced as a methodology which formulates human computation on imprecise words and propositions in natural language. Since its introduction, CW has been a subject of intensive studies; however, a big gap still remains between the theory and application of CW and there has not been yet any working implementation of CW. This research is aimed towards narrowing this gap. First, we provide a formalization of the knowledge representation language in CW, and then we use this formalization to develop a CW Expert System Shell (CWSHELL). CWSHELL is a powerful general purpose expert system capable of performing reasoning on imprecise words and complex propositions drawn from natural language. (Received August 21, 2013)

70 ► Mechanics of particles and systems

1094-70-45 **Juan Carlos Marrero**, **David Martín de Diego** and **Ari Stern*** (astern@math.wustl.edu). *Symplectic groupoids and discrete constrained Lagrangian mechanics.*

The subject of discrete Lagrangian mechanics concerns the study of certain discrete dynamical systems on manifolds, whose geometric features are analogous to those in classical Lagrangian mechanics. While these systems are

quite mathematically interesting, in their own right, they also have important applications to structure-preserving numerical simulation of dynamical systems in geometric mechanics and optimal control theory. In fact, these structure-preserving properties are intimately related to the geometry of symplectic groupoids, Lagrangian submanifolds, and generating functions. In this talk, we describe how a more general notion of generating function can be used to construct Lagrangian submanifolds, and thus discrete dynamics, even for systems with constraints. Within this framework, Lagrange multipliers and their dynamics are shown to arise in a natural way. (Received July 30, 2013)

76 ► Fluid mechanics

1094-76-14 **Landon Kavlie***, UIC Department of Mathematics, 322 Science and Engineering Offices (M/C 249), 851 S. Morgan St, Chicago, IL 60607. *On the Existence of Global Attractors for the 3D Navier-Stokes Equations.*

The existence of global attractors for the autonomous 2D Navier-Stokes equations has been thoroughly researched. In the nonautonomous case, when the uniform attractor exists, its sections have attraction properties which are in a pullback sense, when the initial conditions go to $-\infty$. I will present an abstract framework for studying the existence of pullback attractors for the nonautonomous 3D Navier-Stokes equations where uniqueness of solutions is still unresolved. (Received June 24, 2013)

1094-76-218 **Michele Coti Zelati*** (micotize@indiana.edu), **Michel Frémond**, **Roger Temam** and **Joseph Tribbia**. *A phase transition model in atmospheric dynamics.*

We analyze a system of coupled differential inclusions describing the evolution of the temperature distribution and the specific humidity in a system of moist air. The possible phase change phenomenon (namely, saturation) is modeled by a multivalued Heaviside graph. We present the mathematical formulation of the equations, which involves suitable differential inclusions and variational inequalities, and construct weak solutions by approximation. We discuss the issue of uniqueness of weak solutions, and link this problem to other physically relevant properties of solutions, such as maximum principles and higher regularity. (Received August 24, 2013)

1094-76-331 **Javier Gomez-Serrano*** (jg27@princeton.edu). *Splash singularity for water waves.*

In this talk we will discuss the existence of smooth initial data for the 2D free boundary incompressible Euler equations (also known for some particular scenarios as the water wave problem), for which the smoothness of the interface breaks down in finite time.

Joint work with A. Castro, D. Cordoba, C. Fefferman and F. Gancedo. (Received August 27, 2013)

85 ► Astronomy and astrophysics

1094-85-396 **Dennis G Collins*** (d_collins_pr@hotmail.com), 1519 S. State Rd. 119, Apt. 2, Winamacc, IN 46996-8550. *A Possibly Very Deceiving Flatness.* Preliminary report.

This talk follows a previous talk by the Author AMS Abstract #905-85-247 Jan. 10, 1996 at Orlando, FL on an optical echo theory of quasars. How could a curved space appear flat–a possible answer is given by Author Tim Maltin in the book "Titanic: A Very Deceiving Night." Namely by an atmospheric inversion, events below the horizon around the curvature of the earth could appear straight out, due to changed index of refraction from a denser medium (cold air). However in the Big Bang Theory light comes to us from a denser medium in the past. Thus there is the possibility, looking into the past, that light is always being bent, so that it appears to come straight out (a flat universe), whereas actually it is coming from a spherical-type universe. Consequences are discussed. Preliminary report. (Received August 27, 2013)

91 ► Game theory, economics, social and behavioral sciences

1094-91-387 **Benjamin J Thirey*** (benjamin.thirey@soc.mil), TN. *Just One More Roll: A Question of When to Stop in the Dice Game "Farkle".*

The game "Farkle" is a popular folk dice game in which players acquire points through various combinations of dice which occur following each roll. At any point in the game, players face the simple decision of whether or not to roll the dice again and risk losing all of the points acquired thus far for the chance to acquire additional

points. The problem that the player then faces becomes one of determining the point at which one should stop rolling dice and consolidate gains. Since the game of Farkle has several rules which vary depending upon the source, the optimal stopping point depends heavily upon the rules by which the game are played, and the point assignment to various combinations. (Received August 27, 2013)

92 ► Biology and other natural sciences

1094-92-78 **A. Tridane*** (tridanea@gmail.com), P.O. Box 17551, Al-Ain, United Arab Emirates, **B. El Boukari** (elboukaribrahim@yahoo.fr), Mohammedia, P.O. Box 7955 Sidi Othman, Casablanca, Morocco, and **N. Yousfi** (nourayousfi@hotmail.com), Mohammedia, P.O. Box 7955 Sidi Othman, Casablanca, Morocco. *Global Stability Analysis of HIV Infection Model with Latent Infected $CD4^+$ Reservoir and HAART Therapy Optimization.* Preliminary report.

The aim of this work is to study the global stability of a mathematical model of the HIV infection presented by two types latently infected $CD4^+$, fast and slow, and eight virus genotypes: wild-type, three single mutants, three double mutants and a fully resistant triple mutant. We investigate the different conditions on the basic reproduction number of virus that lead to the global stability of different equilibria point via Lyapunov function. We also study the optimal use of the Highly Active Anti-Retroviral Therapy (HAART) regiments in the case of stable multi-genotype endemic equilibria. Our analyze showed the possibility of optimizing the drug and in order to reduce the virus load and the latent reservoir. (Received August 11, 2013)

1094-92-118 **Lisa Sattenspiel*** (sattenspiell@missouri.edu). *Modeling the spread of influenza through a small community: an agent-based approach.*

Models for disease spread in heterogeneous populations have played a prominent role in mathematical epidemiology since the 1980s. Often systems of differential equations are used to model such populations, and in such models the population is divided into discrete groups on the basis of geography and/or behavior. Mathematical expressions that describe hypothesized patterns of contact among groups are then incorporated into the model. When populations are small, however, the assumptions of differential equations models are not usually met, and other approaches must be used. I describe here an agent-based simulation model that was stimulated by an earlier mathematical model that I developed. The agent-based model centers on modeling a small town in Newfoundland and Labrador, Canada and incorporates individual-based residence patterns, behaviors, and social interactions. The model includes an implicit and dynamic network structure that links individuals within the community. Discussion centers on results from extensive sensitivity analyses of this model, including how different model parameters and components, such as mortality rate, timing of social activities, or household structure, influence patterns of spread of an epidemic such as the 1918 influenza pandemic. (Received August 16, 2013)

1094-92-163 **Maia Martcheva*** (maia@ufl.edu), 147 Hudson Cove, Edgewater, NJ 07020, and **Xue-Zhi Li** (xzli66@126.com), Department of Mathematics, Xinyang Normal University, Xinyang, 464000, Peoples Rep of China. *Competitive exclusion in an infection-age structured model with environmental transmission.*

It has been shown in the past that for the most basic multi-strain ordinary differential equation (ODE) model of SIR-type a competitive exclusion principle holds. The competitive exclusion principle means that the strain with the largest reproduction number persists but eliminates all other strains with suboptimal reproduction numbers. In this talk we extend the competitive exclusion principle to a multi-strain age-since-infection structured model of SIR/SI-type. We also include environmental transmission for each of the pathogens. Using a Lyapunov function, we establish global stability of the disease-free equilibrium if all reproduction numbers are smaller or equal to one. If $\mathcal{R}_j$, the reproduction number of strain j is larger than one, then a single-strain equilibrium, corresponding to strain j exists. This single strain equilibrium is locally stable whenever $\mathcal{R}_j > 1$ and $\mathcal{R}_j$ is the unique maximal reproduction number. If $\mathcal{R}_1 > 1$ is the maximal reproduction number, using a Lyapunov function, we establish that the corresponding single-strain equilibrium $\mathcal{E}_1$ is globally stable. That is, strain one eliminates all other strains, independently of their reproduction numbers as long as they are smaller than $\mathcal{R}_1$. (Received August 21, 2013)

1094-92-239 **Jones M. Mutua*** (jmm7w6@mail.umkc.edu), University of Missouri at Kansas City, Dept of Math Stat 206 Haag Hall, 5100 Rockhill Rd, Kansas City, MO 64110-2499, and **Naveen K. Vaidya** (vaidyan@umkc.edu). *Modeling Co-infection of Malaria and Typhoid Fever: A Case Study in Eastern Province of Kenya.*

Malaria and Typhoid fever are among the most endemic diseases, and so, of major public health importance in developing countries. Particularly, individuals in the tropics are at a greater risk of contracting one or both of these diseases due to poor sanitation and health care. Because of very similar signs and symptoms of malaria and typhoid, false diagnoses resulting in improper treatment and/or care are the major issues in these areas. Moreover, available diagnosis methods, including the most commonly used Widal test, have been found to result in significant false positives. In this talk, I will present a mathematical model to address some issues related to Malaria and Typhoid co-infection. Using our model, I will discuss the basic reproduction number as well as other properties of co-infection dynamics in Eastern Province of Kenya. (Received August 25, 2013)

1094-92-263 **Joseph H Tien*** (jtien@math.ohio-state.edu), **Zhisheng Shuai**, **Marisa C Eisenberg** and **P. van den Driessche**. *Disease invasion of community networks with environmental pathogen movement.*

Consider a set of communities (patches), connected to one another by a network. When can disease invade this network? Intuitively, this should depend upon both the properties of the communities, as well as on the network structure. Here we make this dependence explicit for a broad class of disease models with environmental pathogen movement. In particular, the rooted spanning trees of the network and a generalization of the group inverse of the graph Laplacian play fundamental roles in determining the ability of disease to invade. (Received August 26, 2013)

1094-92-269 **Libin Rong*** (rong2@oakland.edu), Department of Mathematics and Statistics, Oakland University, Rochester, MI 48309. *Modeling hepatitis C virus dynamics in the era of new drugs.*

Chronic hepatitis C virus (HCV) infection remains a public health problem worldwide. Traditional therapy with interferon and ribavirin leads to viral elimination in less than 50% of treated patients. New treatment using direct-acting antiviral agents (DAAs) has significantly increased the cure rate. These new DAA drugs directly interfere with different steps in the HCV life cycle. In this talk, I will discuss recent advances in developing multiscale mathematical models that aim to understand HCV dynamics under therapy with DAAs. The models include both intracellular viral RNA replication and extracellular viral infection. I will address model analysis, approximation, comparison with experimental data, as well as the implication for HCV treatment. (Received August 26, 2013)

1094-92-271 **Naveen K Vaidya*** (vaidyan@umkc.edu), 5100 Rockhill Road, Kansas City, MO 64110. *HIV-1 Treatment in the Face of Drug Resistance: Benefit Analysis via Differential Equations.*

The emergence of drug resistance, which subsequently results in treatment failure, is quite common in many HIV-1 infected patients. In such situations, one of the most challenging questions is whether there is any benefit of continuing therapy. In this talk, I will present how differential equation models can help address some of the issues related to the HIV-1 treatments in the face of drug resistance. I will show that although drug therapy cannot suppress the viral load, it can alter the viral fitness resulting in an increase in CD4+ T cell count, which should yield clinical benefits. Furthermore, this benefit depends on the cell proliferation rate, which, in some situations, produces sustained T-cell oscillations. (Received August 26, 2013)

1094-92-373 **Sonya Bahar*** (bahars@umsl.edu), Dept of Physics and Astronomy, UMSL, One University Blvd, 503 Benton Hall, St. Louis, MO 63121. *Non-Equilibrium Phase Transitions in Evolutionary Dynamics.*

The statistical physics of non-equilibrium phase transitions has recently been applied to models of evolutionary dynamics. I will review recent results showing a transition of the directed percolation universality class in a model where organisms exist on a continuous, two-dimensional phenotype space, undergoing birth and death processes comparable to branching and coalescing random walks. A non-equilibrium transition from a state of extinction to survival occurs as a mutation parameter is varied. Importantly for the biological implications of the model, the transition occurs even on a "neutral" phenotype space, where all organisms have the same probability of reproducing. This corresponds to a control condition in which natural selection is absent. Concurrent with the extinction-to-survival transition, the clustering structure of the organisms in the phenotype space changes as well. An ordinary percolation transition takes place as the clusters of organisms fill the space. Perhaps most interestingly, the centroids of the clusters of organisms also undergo a transition in their clustering dynamics, a

result which has implications for the biologically important problem of multi-level selection. (Received August 27, 2013)

1094-92-402 **Elissa J. Schwartz*** (ejs@wsu.edu), Department of Mathematics, School of Biological Sciences, Box 643113, Pullman, WA 99164, and **Kasia A. Pawelek**, **Karin Harrington**, **Richard Cangelosi** and **Silvia Madrid**. *Immune Control of Equine Infectious Anemia Virus Infection by Cell-Mediated and Humoral Responses.*

Equine Infectious Anemia Virus (EIAV) is a retrovirus that establishes a persistent infection in horses and ponies. The virus is in the same lentivirus subgroup that includes human immunodeficiency virus (HIV). The similarities between these two viruses make the study of the immune response to EIAV relevant to research on HIV. We developed a mathematical model of within-host EIAV infection dynamics that contains both humoral and cell-mediated immune responses. Analysis of the model yields results on thresholds that would be necessary for a combined immune response to successfully control infection. Numerical simulations are presented to illustrate the results. These findings have the potential to lead to immunological control measures for lentiviral infection. (Received August 28, 2013)

93 ► Systems theory; control

1094-93-13 **Nick Wintz*** (nwintz@lindenwood.edu), Lindenwood University, Department of Mathematics, 209 S Kingshighway, St Charles, MO 63301, and **Martin Bohner** (bohner@mst.edu), Missouri University of Science and Technology, Department of Mathematics and Statistics, 870 Miner Circle, Rolla, MO 65409. *The Kalman Filter for Linear Systems on Time Scales.*

We introduce the Kalman filter for linear systems on time scales, which includes the discrete and continuous versions as special cases. When the system is also stochastic, we show that the Kalman filter is an observer that estimates the system when the state is corrupted by noisy measurements. Finally, we show that the duality of the Kalman filter and the Linear Quadratic Regulator (LQR) is preserved in their unification on time scales. A numerical example is provided. (Received June 19, 2013)

1094-93-97 **Dylan R Poulsen*** (dylan_poulsen@baylor.edu), Waco, TX, and **John M Davis** and **Ian Gravagne**. *Stability of Markov Chains: A Time Scales Viewpoint with Applications to Control.*

We present a version of Lyapunov theory for stochastically generated time scales. In the case of quadratic Lyapunov functions for the LTI case, our results improve the requirement that $spec(A) \subset \mathcal{H}_{\min}$. Our approach also allows us to consider a special class of LTV problems where the dependence on time is only through the graininess. As an application of these results, we consider observer-based state feedback where the time between sampling points is not known *a priori*, but has known statistical properties. In particular, we assume that the distance between sampling points is an independent sequence of random variables with known mean and variance. (Received August 14, 2013)

1094-93-264 **Geoffrey Eisenbarth*** (geoffrey_eisenbarth@baylor.edu), **John M. Davis** and **Ian Gravagne**. *Stability of Simultaneously Triangularizable Switched Systems on Time Scales.*

Switched systems comprise a convenient class of time varying systems with nice properties. While there are numerous papers discussing the stability of switched systems evolving over $\mathbb{R}$ and $\mathbb{Z}$, little has been done in the context of time scale domains.

In this talk, we extend to time scales several results which provide sufficient conditions for global stability via the existence of quadratic Lyapunov functions. In particular, we generalize results of Liberzon, Hespanha, and Morse to switched systems with hybrid non-uniform discrete and continuous domains, and generalize the authors' results from a previous talk to a larger class of switched systems. In addition, we explore an easily checkable characterization of our required hypothesis for the theorems. Finally, conditions are stated under which there exists a stabilizing switching pattern for a collection of (not necessarily stable) linear systems and separate criteria are formed which imply the stability for a given switching pattern, given *a priori*. (Received August 26, 2013)

1094-93-305 **John M Davis*** (john_m_davis@baylor.edu), Department of Mathematics, Baylor University, Waco, TX 76798, **Ian A Gravagne** (ian_gravagne@baylor.edu), Dept. of Electrical & Computer Engineering, Baylor University, Waco, TX 76798, and **Dylan Poulsen** (dylan_poulsen@baylor.edu), Department of Mathematics, Baylor University, Waco, TX 76798. *Time Scale-Based Observer Design for Battery State-of-Charge Estimation.*

In this talk, we explore a promising new application of time scales theory to the problem of constructing an observer for estimating the state-of-charge in a particular battery configuration. The upshot is that a time scales approach very naturally points to hardware designs that require less power to operate than standard observer designs, while also increasing the the accuracy of the underlying estimator relative to Coulomb counting methodologies. (Received August 26, 2013)

94 ► Information and communication, circuits

1094-94-25 **Joseph D Lakey*** (jlakey@nmsu.edu), Department of Mathematical Sciences, New Mexico State University, Las Cruces, NM 88003-8001, and **Jeffrey A Hogan** (jeff.hogan@newcastle.edu.au), School of Mathematical and Physical Sciences, University of Newcastle Australia, Callaghan, NSW 2308, Australia. *Frames for duration and bandwidth limiting.* Preliminary report.

Every bandlimited function is locally approximately time limited. The bandlimited functions most concentrated in a given time interval are the low-order prolate spheroidal wave functions corresponding to a fixed duration-bandwidth product. That every bandlimited function is locally approximately time limited means that every such function is locally approximately in the span of those prolates that have at least half of their energies in the given time-concentration interval. We quantify this more precisely by showing that suitable shifts of such prolates form a frame for the Paley-Wiener space. We also relate this frame result with the sampling theorem. (Received July 15, 2013)

1094-94-203 **Eric S Weber*** (esweber@iastate.edu), Department of Mathematics, Iowa State University, Ames, IA 50011, and **Sa'Ud al-Sa'Di** (saud@hu.edu.jo), Department of Mathematics, Hashemite University, Zarqa, 13115, Jordan. *Sampling in de Branges spaces of entire functions.*

We consider the problems of sampling and interpolation in de Branges spaces–Hilbert spaces of entire functions which are square integrable on the real line with respect to some weight function and satisfy some growth conditions. The class of de Branges spaces considered are those whose weight function has a phase function which is bounded below. For this class, we prove that the Homogeneous Approximation Property holds for the reproducing kernel. As a consequence, necessary conditions for sampling and interpolating sequences are shown, which generalize some well-known sampling and interpolation results in the Paley-Wiener space. (Received August 23, 2013)

00 ► General

1095-00-91 **Huiyi Hu*** (huiyihu@math.ucla.edu), **Thomas B. Laurent** (laurent@math.ucr.edu), **Mason A. Porter** (porterm@maths.ox.ac.uk) and **Andrea L. Bertozzi** (bertozzi@math.ucla.edu). *A Method Based on Total Variation for Network Modularity Optimization using the MBO Scheme.*

The study of network structure is pervasive in sociology, biology, computer science, and many other disciplines. One of the most important areas of network science is the algorithmic detection of cohesive groups of nodes called "communities". One popular approach to find communities is to maximize a quality function known as *modularity* to achieve some sort of optimal clustering of nodes. In this paper, we interpret the modularity function from a novel perspective: we reformulate modularity optimization as a minimization problem of an energy functional that consists of a total variation term and an ℓ_2 balance term. By employing numerical techniques from image processing and ℓ_1 compressive sensing—such as convex splitting and the Merriman-Bence-Osher (MBO) scheme—we develop a variational algorithm for the minimization problem. We present our computational results using both synthetic benchmark networks and real data. (Received August 31, 2013)

1095-00-192 **Nicolas Garcia***, Carnegie Mellon University, 5000 Forbes Avenue, Wean Hall 6109, Pittsburgh, PA 15213, and **Dejan Slepcev**. *Γ-convergence of perimeter on random geometric graphs.*

Motivated by the applications to analysis of data clouds, we study the notion of perimeter on the set V_n of n random, uniformly distributed points in a domain in the Euclidean space. The weighted graph representing the configuration is created by setting the vertices to be the random points and assigning the edges and their weights based on the distances between the points. This includes setting a length scale ϵ such that significant weight is given to edges of length up to ϵ. The perimeter of $A_n \subset V_n$ is defined based on weights of edges between A_n and $V_n \backslash A_n$. We investigate under which scaling of ϵ on n do the functionals which assign the graph perimeter converge to the perimeter in the Euclidean space. We consider this question in the setting of Γ-convergence. We obtain nearly optimal rates on the scaling $\epsilon(n)$ for Γ-convergence to hold. (Received September 09, 2013)

1095-00-238 **Michaela Puck Rombach*** (puckrombach@gmail.com), UCLA Mathematics Department, Box 951555, Los Angeles, CA 90095-1555, and **Mason A Porter**, **James H Fowler** and **Peter J Mucha**. *Core-Periphery Structure in Networks.*

Intermediate-scale (or 'meso-scale') structures in networks have received considerable attention, as the algorithmic detection of such structures makes it possible to discover network features that are not apparent either at the local scale of nodes and edges or at the global scale of summary statistics. Numerous types of meso-scale structures can occur in networks, but investigations of such features have focused predominantly on the identification and study of community structure. In this paper, we develop a new method to investigate the meso-scale feature known as core-periphery structure, which entails identifying densely-connected core nodes and sparsely-connected periphery nodes. In contrast to communities, the nodes in a core are also reasonably well-connected to those in the periphery. Our new method of computing core-periphery structure can identify multiple cores in a network and takes different possible cores into account. We illustrate the differences between our method and several existing methods for identifying which nodes belong to a core, and we use our technique to examine core-periphery structure in examples of friendship, collaboration, transportation, and voting networks. (Received September 10, 2013)

05 ► Combinatorics

1095-05-22 **Daniel Orr** and **Mark Shimozono*** (mshimo@math.vt.edu), Department of Mathematics, 460 McBryde Hall, Virginia Tech, Blacksburg, VA 24061. *Combinatorial formulas for various specializations of nonsymmetric Macdonald polynomials.* Preliminary report.

We present combinatorial formulas for various specializations of nonsymmetric Macdonald polynomials. They are obtained by characterizing the terms that survive the specialization of the Ram-Yip formula. The specialization

of nonsymmetric Macdonalds at t = infinity (and setting q to 1/q) yield elements whose coefficients at weights are nonnegative polynomials in q. Cherednik and the first author studied this case and conjectured that it describes the PBW filtration of an affine Demazure module. We obtain a combinatorial formula for this case and use it to verify their conjecture about the coefficients of extremal weights. As in the t = 0 specialization studied by Lenart, Naito, Sagaki, Schilling and the second author, the quantum Bruhat graph controls which alcove paths are allowable. In the case q = infinity one obtains the Whittaker functions studied by Brubaker, Bump, and Licata. We obtain a formula for these, but the summands are monomials in X multiplied by powers of t and (1-t). (Received August 01, 2013)

1095-05-29 **Jessica Delgado*** (delgado3@hawaii.edu), University of Hawaii, Department of Mathematics, 2565 McCarthy Mall, Honolulu, HI 96822. *Higher-Dimensional Frobenius Gaps.*

This research expands on the well studied Frobenius problem and examines a related problem. We focused on very ample polytopes of dimension three and their gaps, lattice points in the homogenization of the polytope that cannot be written as integer combinations of lattice points in the poytope. The main result is a theorem which states a universal upper bound of the gaps of very ample polytopes in dimension three does not exist. We built a program to compute the gaps of any very ample polytope. The computations of explicit examples are used to prove the main result on the nonexistence of the upper bound as well as a conjecture on the behavior of the gaps. (Received August 15, 2013)

1095-05-144 **Pietro Poggi-Corradini*** (pietro@math.ksu.edu), **Nathan Albin**, **Faryad Darabi Sahneh** and **Max Goering**. *Modulus of curve families on graphs.* Preliminary report.

We define a notion of modulus for curve families on graphs and discuss some of its properties, with a focus on adapting concepts that were introduced in the general metric space setting to the particular case of graphs. We also recall Beurling's criterion and make a connection with the so-called Karush-Kuhn-Tucker Theorem in convex optimization, which is a generalization of Lagrange multipliers. However, because of the way curve families are usually defined, computing their modulus is not as straightforward as applying well-known optimization algorithms. Instead, taking Beurling's criterion as a guide, we propose an algorithm to compute modulus of curve families on graphs and we describe some of its features. (Received September 06, 2013)

1095-05-155 **Alessandra Graf*** (ag668@nau.edu). *Recent Developments Concerning Two Conjectures by Frucht.*

A graceful labeling of a graph G with q edges is an injective assignment of labels from $\{0, 1, \ldots, q\}$ to the vertices of G such that when each edge is assigned the absolute value of the difference of the vertex labels it connects, the resulting edge labels are distinct. In a 1978 paper, Roberto Frucht made some intriguing conjectures while investigating graceful labelings of coronas $C_n \odot K_1$. We will summarize results from recent papers that address these conjectures, and discuss some newer developments. (Received September 07, 2013)

1095-05-167 **Ehsan Kamalinejad*** (ehsan.kamalinejad@gmail.com), 555 West middlefield road, apt # M304, MOUNTAIN VIEW, CA 94043, **Kevin Costello** (costello@math.ucr.edu), School of Mathematics, University of California, Riverside, 900 University Ave, Riverside, CA 92521, and **Thomas Laurent** (tlaurent@lmu.edu), Department of Mathematics, University of California, Riverside, 900 University Ave, Riverside, CA 92521. *Sparsification for Total Variation Clustering.* Preliminary report.

Total variation clustering algorithms have proved to be a strong tool for partitioning graphs. However, it is difficult to apply these algorithms to big data sets because of non-linear time complexity. We use a sampling algorithm based on spanning trees and Nagamochi-Ibaraki index to sparsify the graphs as a preprocessing step. This sampling algorithm, being compatible with total variation structure, gives results close to that of running the partitioning algorithm on the original graph while boosting up the speed of the clustering algorithm significantly. (Received September 08, 2013)

1095-05-187 **Monica Vazirani***, Department of Mathematics, One Shields Ave, Davis, CA 95616, and **Kevin Walker**. *Representations of the affine BMW algebra.*

The BMW algebra is a deformation of the Brauer algebra, and has the Hecke algebra of type A as a quotient. Its specializations play a role in types B, C, D akin to that of the symmetric group in Schur-Weyl duality. One can enlarge these algebras by a commutative subalgebra X to an affine, or annular, version. Unlike the affine Hecke algebra, the affine BMW algebra is not of finite rank as a right X-module, so induction functors are ill-behaved, and many of the classical Hecke-theoretic constructions of simple modules fail. However, the affine BMW algebra still has a nice class of X-semisimple, or calibrated, representations, that don't necessarily factor through the

affine Hecke algebra. I will discuss Walker's TQFT-motivated 1-handle construction of the X-semisimple, or calibrated, representations of the affine BMW algebra. (Received September 09, 2013)

1095-05-244 **Michael Chmutov*** (mchmutov@umich.edu), **Shifra Reif** and **Crystal Hoyt**. *A combinatorial model for highest weights of finite dimensional representations of* $\mathfrak{gl}(m,n)$. Preliminary report.

We present a combinatorial tool to study highest weights of a finite dimensional representation of general linear Lie superalgebra and use it to prove the Kac-Wakimoto character formula stated in 1994. We also apply this tool to give an alternative proof of the Moens-Van der Jeugt theorem that covariant representations (whose characters are the super-Schur functions) are tame. Joint with C. Hoyt and S. Reif. (Received September 10, 2013)

1095-05-270 **Alan Krinik** and **David Nguyen***, Cal Poly Pomona, Department of Mathematics and Statistics, Pomona, CA 91768. *Counting lattice paths that have steps of size one or two.* Preliminary report.

A recurrence relation is developed for counting lattice paths on {0,1,2,3,4,...} that generally move up or down in step sizes of one or two (except at state 0 which has only upward steps and state 1 where only downward steps of size one are allowed in addition to possible upward steps of size one or two). This result has applications to determining transient probabilities of queueing systems that have the same sample path structure. (Received September 10, 2013)

06 ► Order, lattices, ordered algebraic structures

1095-06-220 **Lenny Fukshansky** (lenny@cmc.edu), 850 Columbia Avenue, Claremont, CA 91711, and **Xun Sun*** (foxfur_32@hotmai.com), 168 E La Sierra Dr, Arcadia, CA 91006. *Complexity of lattice problems on cyclic lattices.*

Cyclic lattices are sublattices of $\mathbb{Z}^N$ that are preserved under the rotational shift operator. Cyclic lattices were introduced by D. Micciancio in 2002 and their properties were studied in the recent years by several authors due to their importance in cryptography. In particular, Peikert and Rosen showed that on cyclic lattices of prime dimension N, the shortest independent vectors problem SIVP reduces to the shortest vector problem SVP with a particularly small loss in approximation factor, as compared to general lattices. In this talk, we further investigate geometric properties of cyclic lattices, in particular proving that SVP is in fact equivalent to SIVP on a positive proportion of cyclic lattices in every dimension N. (Received September 09, 2013)

1095-06-234 **Lenny Fukshansky** and **Hiren Maharaj*** (hmahara@g.clemson.edu). *Function Field Lattices from Elliptic Curves.* Preliminary report.

Tsfasman and Vladut introduced a construction of lattices, called function field lattices, from algebraic curves over finite fields in their book "Aglebraic-Geometric codes". In this talk we will discuss properties of lattices from this construction applied to elliptic curves. In particular, we will talk about generating sets, well-roundedness and the number of minimal vectors. (Received September 10, 2013)

11 ► Number theory

1095-11-4 **Paul Vojta*** (vojta@math.berkeley.edu), University of California, Department of Mathematics, 970 Evans Hall #3840, Berkeley, CA 94720-3840. *Diophantine geometry, Nevanlinna theory, and abc.* Preliminary report.

For over 30 years now, it has been known, by work of C. Osgood, S. Lang, and the speaker, that many theorems and conjectures in diophantine geometry (in number theory) bear a close formal resemblance to statements in Nevanlinna theory (in complex analysis). This talk will briefly recall this analogy, describe recent progress in these areas, and discuss key issues impacting its further development. The abc conjecture (or theorem?) is a major part of the latter (but, due to the speaker's lack of expertise in elliptic curves, not much will be said about Mochizuki's announced proof of the abc conjecture). (Received September 09, 2013)

1095-11-30 **Alexandru Buium*** (buium@math.unm.edu), Department of Mathematics and Statistics, University of New Mexico, Albuquerque, NM 87131. *Hamiltonian formalism in arithmetic geometry.* Preliminary report.

The geometric theory of differential equations has an arithmetic analogue in which functions are replaced by numbers. The talk explores the arithmetic analogue of the Hamiltonian formalism. It turns out, for instance, that classical differential equations with Hamiltonian structure, such as the Painleve' VI equation, have an arithmetic Hamiltonian counterpart. The talk is based on joint work with Yu. I. Manin and on joint work with A. Saha. (Received August 16, 2013)

1095-11-37 **Bryan F Clair*** (bryan@slu.edu). *The Ihara zeta function of the infinite grid.*

The Ihara zeta function of a graph is the generating function for closed loops in the graph. For finite graphs, the Ihara zeta function is always a polynomial, but for infinite graphs it is given by a power series and needs to be analytically continued. In this talk, we compute the Ihara zeta function for the infinite grid as an integral over the torus, depending on a complex parameter. This same integral appears in the classical Ising model of a magnet, where only real values of the parameter are of physical interest. Using Elliptic integrals, the zeta function extends to a multivalued complex function with finitely many singular values in the plane. (Received August 21, 2013)

1095-11-77 **David Krumm*** (dkrumm@cmc.edu). *Preperiodic points for quadratic polynomials, I.*

This is the first in a series of two talks in which John Doyle and I will give an overview of a project in arithmetic dynamics that we've developed jointly with Xander Faber. In this talk I will explain the uniform boundedness conjecture of Morton and Silverman, the particular case of this conjecture studied by Poonen, and the main questions we wish to answer in our project. These questions were motivated by a large gathering of data which required new algorithms in algebraic number theory, so I will briefly explain our methods. (Received August 28, 2013)

1095-11-106 **Andrew G. Earnest***, Department of Mathematics, Southern Illinois University, Carbondale, IL 62901, **Ji Young Kim**, Department of Mathematical Sciences, Seoul National University, Seoul, 151-742, South Korea, and **Nicolas D. Meyer**, Department of Mathematics, Southern Illinois University, Carbondale, IL 62901. *Lattice Representations with Primitivity Conditions.*

We will discuss a local-global theorem for the representation of quadratic lattices with primitivity conditions imposed at a finite set of primes, and illustrate its use to prove that certain quaternary lattices are strictly regular, in the sense that they globally primitively represent all integers that they primitively represent everywhere locally. (Received September 03, 2013)

1095-11-124 **Chantal David**, **Derek Garton**, **Zachary Scherr**, **Arul Shankar**, **Ethan Smith** and **Lola Thompson*** (lola.thompson@oberlin.edu). *Abelian surfaces over finite fields with prescribed groups.*

Let A be an abelian surface over $\mathbb{F}_q$. The rational points on $A/\mathbb{F}_q$ form an abelian group $A(\mathbb{F}_q) \simeq \mathbb{Z}/n_1\mathbb{Z} \times \mathbb{Z}/n_1n_2\mathbb{Z} \times \mathbb{Z}/n_1n_2n_3\mathbb{Z} \times \mathbb{Z}/n_1n_2n_3n_4\mathbb{Z}$. We are interested in knowing which groups of this shape actually arise as the group of points on some abelian surface over some finite field. For a fixed prime power q, a characterization of the abelian groups that occur was recently found by Rybakov. One can use this characterization to obtain a set of congruences modulo the integers n_1, n_2, n_3, n_4 on certain combinations of coefficients of the corresponding Weil polynomials. We use Rybakov's criterion to show that groups $\mathbb{Z}/n_1\mathbb{Z} \times \mathbb{Z}/n_1n_2\mathbb{Z} \times \mathbb{Z}/n_1n_2n_3\mathbb{Z} \times \mathbb{Z}/n_1n_2n_3n_4\mathbb{Z}$ do not occur if n_1 is very large with respect to n_2, n_3, n_4, and occur with density zero in a wider range of variables. (Received September 05, 2013)

1095-11-130 **P Guerzhoy*** (pavel@math.hawaii.edu), Dept of Math, 2565 McCarthy Mall, University of Hawaii at Manoa, Honolulu, HI 96822. *On a classical Diophantine problem after Tunnell, Zagier, and Skoruppa.* Preliminary report.

The congruence number problem goes back to a question by Diophantus: given a positive integer n, determine whether or not n is the area of a right triangle with rational sides. In 1983, Tunnell put this problem into the framework of modular forms of weight 3/2, and presented a solving algorithm. This algorithm boils down to calculating n-th Fourier coefficients of certain weight 3/2 modular forms presented as ternary theta-series. In 1991, Skoruppa produced another, quite different algorithm of calculating essentially same coefficients based on the theory of Jacobi forms. We present yet another algorithm which comes as a variation on the theme of a work by Zagier (1999). Although our algorithm is very close to that produced by Skoruppa, a conceptual proof

of the equivalence of the two turns out to be involved. This presentation is about an ongoing project joint with K. Bringmann and B. Kane. (Received September 06, 2013)

1095-11-135 **John R. Doyle*** (jdoyle@math.uga.edu), Department of Mathematics, University of Georgia, Athens, GA 30602. *Preperiodic points for quadratic polynomials, II.*

In this sequel to David Krumm's talk, I will describe some of the results we've obtained in our joint work with Xander Faber. Our main questions are the following: First, given a quadratic extension K of the rational numbers, and given a quadratic polynomial $f(z)$ defined over K, how large can the set of K-rational preperiodic points for $f(z)$ be? Second, what sort of structure can this set have as a directed graph? These questions were motivated by work of Poonen, who studied the same question over the rationals. I will give an overview of our methods, and I will discuss the progress we've made toward answering the main questions. (Received September 06, 2013)

1095-11-137 **J. Carmelo Interlando*** (interlan@mail.sdsu.edu), San Diego State University, Department of Mathematics and Statistics, 5500 Campanile Drive, GMCS 415, San Diego, CA 92182-7720. *New Dense Lattice Packings via Linear Algebra.*

Let A and B be lattices of dimensions m and n, both greater than one. It is no loss of generality to assume that $d_{\min}(A) = d_{\min}(B) = 1$. We first note that A and B can always be immersed in $\mathbb{R}^{m+n-1}$ and then glued along their common sublattice $\mathbb{Z}$ generated by one of the shortest vectors. This simple observation yields lattices of record center densities in dimensions 248, 520, and 4098. Furthermore, if the kissing numbers of A and B are greater than one and the lattices have a common sublattice C of dimension two, then we show that A and B can be immersed in $\mathbb{R}^{m+n-2}$ and then glued along C. This type of construction yields sphere packings denser than previously known ones in dimensions 52, 68, and 84. The relevant parameters (dimension, minimum distance, and kissing number) of the new lattices are given in terms of the respective parameters of A, B, and C. (Received September 06, 2013)

1095-11-169 **James Ricci*** (jricci@wesleyan.edu), Department of Mathematics and Comp. Sci., Science Tower 655, 265 Church Street, Middletown, CT 06459. *Finiteness results for regular ternary quadratic polynomials.* Preliminary report.

Any quadratic polynomial can be written in the form $f(x) = Q(x) + l(x) + c$ where Q is a quadratic form, l is a linear form, and c is a constant; it is called regular if it represents all the integers which are represented locally by the polynomial itself over $\mathbb{Z}_p$ for all primes p. Given a positive definite Q, we can associate certain types of quadratic polynomials to a coset of a $\mathbb{Z}$-lattice in order to view quadratic polynomials through the geometric perspective of quadratic spaces and lattices. In this talk we will define an invariant called the conductor, a notion of a semi-equivalence class of a regular quadratic polynomial and present our result: Given a fixed conductor, there are finitely many semi-equivalence classes of primitive regular integral quadratic polynomials in three variables. (Received September 08, 2013)

1095-11-174 **Robert Grizzard*** (rgrizzard@math.utexas.edu). *Relative Bogomolov extensions.*

A field K of algebraic numbers is said to satisfy the Bogomolov property if the absolute logarithmic height of non-torsion points of $K^\times$ is bounded away from 0 (K "has no small points"). This can be generalized by defining a relative extension L/K to be Bogomolov if the height of points of $L^\times \setminus K^\times$ is bounded away from 0 ("L has no new small points"). We'll survey existing results on the Bogomolov property and give several non-trivial examples of relative Bogomolov extensions where the base field does not have the Bogomolov property. (Received September 08, 2013)

1095-11-175 **Anna R Haensch*** (haenscha@duq.edu), Departmen of Mathematics and Computer Science, Duquesne University, 600 Forbes Ave., Pittsburgh, PA 15282. *Finding a local-global principle for inhomogeneous quadratic polynomials of rank 3.*

Finding an integral analogue to Hasse's local-global principle for quadratic forms has been a driving force behind much recent work in number theory. For quadratic lattices of rank 3 or greater, Duke and Schulze-Pillot obtained a satisfactory solution in 1990, by way of an asymptotic local-global principle.

In 1994, Joechner and Kitaoka showed that for lattices of rank 4 and greater, these representations approximate a family of local solutions, for finitely many primes. A consequence of the existence of this approximation property, is a local-global principle for inhomogeneous quadratic polynomials of rank 4 and greater.

Towards an ultimate goal of obtaining a local-global principle for ternary inhomogeneous quadratic polynomials, the next interesting step would be to develop an approximation property for ternary quadratic lattices.

This talk will describe one method which has been used to approach this problem, using the theory of quadratic lattices and spinor norms. (Received September 08, 2013)

1095-11-177 **Nick Rauh*** (nrauh@math.utexas.edu). *An Alternative Formulation of Arithmetic Bezout with Applications to Diophantine Problems.*

An alternative approach to formulating Arithmetic Bezout type theorems will be outlined, focusing more on formal properties of resultants and height inequalities than deep algebraic geometry. We will then examine some applications to Cassels search bound problems, including a proof of the quadratic case in the spirit of Cassels' original approach. (Received September 08, 2013)

1095-11-184 **Gordon Heier*** (heier@math.uh.edu), Department of Mathematics, University of Houston, 4800 Calhoun Road, Houston, TX 77004, and **Min Ru**. *Essentially large divisors and their arithmetic and function-theoretic inequalities.*

Motivated by the classical Theorems of Picard and Siegel and their generalizations, we define the notion of an essentially large effective divisor and derive some of its arithmetic and function-theoretic consequences. We also discuss necessary and sufficient criteria for divisors to be essentially large. (Received September 08, 2013)

1095-11-202 **Katherine Thompson*** (kthompson0721@gmail.com), **Pete L Clark** and **Jacob Hicks**. *Geometry of Numbers and Positive Definite Quadratic Forms.*

Applications of Geometry of Numbers (GoN) are prevalent throughout the last 200 years of number theory. Classically recognized GoN proofs include the universality of the sum of four squares over the integers. The speaker, along with Pete L. Clark and Jacob Hicks, has used theoretical and computational generalizations of the techniques in the proof of four squares theorem to provide universality proofs for over 100 additional four-variable positive definite quadratic forms over the integers. Future directions and additional GoN applications will be discussed as time permits. This work has its roots in a UGA VIGRE group led by Pete L. Clark on GoN. (Received September 09, 2013)

1095-11-229 **Abhinav Kumar*** (abhinav@math.mit.edu), Cambridge, MA 02139. *Neron-Severi lattices of K3 surfaces of high rank, and arithmetic applications.* Preliminary report.

I will talk about the Neron-Severi and Mordell-Weil lattices of elliptic K3 surfaces of high rank, connected to Kummer surfaces of a product of elliptic curves, and some arithmetic connections and open questions. This is joint work with Masato Kuwata. (Received September 09, 2013)

1095-11-230 **Aaron Levin***, Department of Mathematics, Michigan State University, 619 Red Cedar Road, East Lansing, MI 48824. *Integral points of bounded degree on curves.* Preliminary report.

We give a characterization of affine curves possessing infinitely many integral points of degree d over some number field. (Received September 10, 2013)

1095-11-246 **Cassie L Williams*** (willi5cl@jmu.edu), James Madison University, Harrisonburg, VA. *Lattices of orders, conjugacy classes of matrices, and isogeny of abelian varieties.* Preliminary report.

An isogeny class of abelian varieties over $\mathbb{F}_p$ is determined by the characteristic polynomial of its Frobenius endomorphism, f. For elliptic curves, one can find a formula for the size of such an isogeny class by summing class numbers of members of a certain lattice of orders in a quadratic imaginary field. In 2003, Gekeler related a proportion of matrices with characteristic polynomial f to these class numbers, and thus to the size of a chosen isogeny class. To extend, we compute the analogous ratio of matrices in GSp_4 and find a relation to a ratio of class numbers in a quartic imaginary field. Then we use an appropriate lattice of orders and results of Everett Howe to work towards a formula for the size of an isogeny class of abelian surfaces. (Received September 10, 2013)

13 ► Commutative rings and algebras

1095-13-25 **Bethany Kubik**, **Chelsey Paulsen** and **Sean Sather-Wagstaff*** (sean.sather-wagstaff@ndsu.edu). *Path ideals for weighted graphs.* Preliminary report.

Given a (finite simple) graph G, the edge ideal of G is a square-free monomial ideal generated by the edges of G. This is a fairly well-studied invariant of G. Recently, the r-path ideal of G has been introduced and studied when G is a tree. We study this ideal for arbitrary G. Moreover, we introduce versions of these ideals when G is a weighted graph. These ideals are not square-free in general. We give explicit descriptions of their primary

decompositions, and we present some criteria for these ideals to be Cohen-Macaulay. (Received August 06, 2013)

1095-13-81 **Lokendra P Paudel*** (lokendra@nmsu.edu), Las Cruces, NM 88003. *Approximation of Valuations and Realization of Lattice-Ordered Groups Over Affine Domains.*

A lattice-ordered group (ℓ-group) G is called realizable over $D = k[x_1, x_2, ..., x_n]$ if there exists a Bézout overring R (meaning every finitely generated ideal is principal) of D such that the group of divisibility of R is order isomorphic to G. The goal of this presentation is to describe the semilocal ℓ-groups that arise as the group of divisibility of a finite intersection of valuation overrings of D, especially for $n = 1, 2$ and 3. (Received August 30, 2013)

1095-13-82 **Janet C. Vassilev*** (jvassil@math.unm.edu), Department of Mathematics and Statistics, Albuquerque, NM 87131. *Star and semistar operations defined on rings with zero divisors.* Preliminary report.

The theory of star and semistar operations has been developed mostly over domains. Recently, Epstein defined star and semistar operations over more general commutative rings. We will compare some of the known results over domains with the non-domain setting. There are some striking differences. (Received August 30, 2013)

1095-13-92 **Jesse Burke*** (jburke@math.ucla.edu). *Twisting cochains and free resolutions over commutative rings.* Preliminary report.

Classical Koszul-Moore duality uses a twisting cochain to give functors between the category of comodules over a differential graded coalgebra and the category of modules over an augmented differential graded algebra. Positselski has generalized this to the case of non-augmented differential graded algebras: to compensate one must add a curvature term to the coalgebra.

I will discuss how this duality can be used to construct free resolutions over commutative rings. Specifically, let Q be a commutative ring and $R = Q/I$ for some ideal I. Starting with a free resolution of R over Q that is a dga (or even an A_∞-algebra), this machinery allows one to construct an R-free resolution from a Q-free resolution, for any R-module. This generalizes a result of Iyengar and highlights the role of higher homotopies in free resolutions over commutative rings. This situation is particularly nice when I can be generated by a regular sequence. (Received September 01, 2013)

1095-13-98 **Adam Boocher*** (aboocher@math.berkeley.edu) and **Federico Ardila** (federico@sfsu.edu). *The Closure of a Linear Space in* $(\mathbb{P}^1)^n$.

If $L \subset \mathbb{A}^n$ is a linear space then we can take its closure in $(\mathbb{P}^1)^n$ once we fix coordinates. In this talk I'll present joint work with Federico Ardila concerning the defining ideal I of the closure. It turns out the combinatorics of this ideal are completely determined by a matroid associated to L. We compute I explicitly as well as its degree, universal Gröbner basis, and initial ideals - all with a few ideas from matroid theory. (Received September 02, 2013)

1095-13-102 **Susan E. Morey*** (morey@txstate.edu), Department of Mathematics, Texas State University, 601 University Dr., San Marcos, TX 78666. *Properties of Square-free Monomial Ideals.*

There is a natural one-to-one correspondence between square-free monomial ideals generated in degree two and graphs through the construction of edge ideals. This correspondence extends naturally to one between arbitrary square-free monomial ideals and simple hypergraphs, also called clutters or Sperner families, or to facets of a simplicial complex. Using this correspondence, algebraic properties of ideals can be translated into graph theoretic or combinatorial properties. This lexicon allows techniques from one of these fields to be used to answer questions from another. This talk will focus on classes of square-free monomial ideals that have a graphical representation, such as edge ideals or path ideals of a graph. We will use such representations to examine algebraic invariants of interest in Algebraic Geometry, such as depths and associated primes, of such ideals and their powers. (Received September 03, 2013)

1095-13-125 **Bruce Olberding*** (olberdin@nmsu.edu), Department of Mathematical Sciences, New Mexico State University, Las Cruces, NM 88003-8001. *On the geometry of Prüfer intersections of valuation rings.*

Let F be a field, let D be a subring of F and let Z be an irreducible subspace of the space of all valuation rings between D and F that have quotient field F. Then Z is a locally ringed space whose ring of global sections is $A = \bigcap_{V \in Z} V$. All rings between D and F that are integrally closed in F arise in such a way. Motivated by applications in areas such as multiplicative ideal theory and real algebraic geometry, a number of authors have

formulated criteria for when A is a Prüfer domain. We give geometric criteria for when A is a Prüfer domain that reduce this issue to questions of prime avoidance. These criteria, which unify and extend a variety of different results in the literature, are framed in terms of morphisms of Z into the projective line $\mathbb{P}^1_D$. (Received September 05, 2013)

1095-13-126 **Tom Marley*** (tmarley1@unl.edu). *The Frobenius functor and injective modules.*
We investigate commutative Noetherian rings of prime characteristic such that the Frobenius functor applied to any injective module is again injective. We characterize the class of one-dimensional local rings with this property and show that it includes all one-dimensional F-pure rings. We also give a characterization of Gorenstein local rings in terms of $\mathrm{Tor}_i^R(R^f, E)$, where E is the injective hull of the residue field and R^f is the ring R whose right R-module action is given by the Frobenius map. (Received September 05, 2013)

1095-13-134 **Stepan Paul*** (stpaul@calpoly.edu), Department of Mathematics, California Polytechnic State University, San Luis Obispo, CA 93407-0403. *A duality theorem for syzygies of Veronese ideals of weighted projective space.*
We prove a purely combinatorial duality theorem for the reduced homology groups of a certain class of simplicial complexes. Sturmfels showed how to use these reduced homology groups to calculate the multigraded Betti number of toric ideals; for the ideals of Veronese embeddings weighted projective space, we are able to give a dual formula. We use this duality to show how close to being Gorenstein the quotients by these Veronese ideals are. We also give a closed formula for the rank of the highest nonzero syzygy of these Veronese ideals. (Received September 06, 2013)

1095-13-136 **Tai H Ha*** (tha@tulane.edu), Tulane University, Department of Mathematics, 6823 St. Charles Avenue, New Orleans, LA 70002. *Symbolic powers of monomial ideals.*
In investigating containments between symbolic and ordinary powers of homogeneous ideals (particularly, the defining ideals of fat point schemes), Harbourne and Huneke proposed a list of conjectures. In this talk, we address some of those conjectures (and their extensions) for monomial ideals. Specifically, for square-free monomial ideals we prove a general containment between their symbolic and ordinary powers. (Received September 06, 2013)

1095-13-148 **Branden Stone*** (bstone@bard.edu), **Courtney Gibbons**, **Jack Jeffries**, **Sarah Mayes**, **Claudiu Raicu** and **Bryan White**. *Non-simplicial decompositions of Betti diagrams of complete intersections.*
The framework of Boij-Söderberg theory allows us to decompose Betti diagrams over a polynomial ring into pure diagrams. In this talk, we relax the requirement that the degree sequences in such pure diagrams be totally ordered. As a result, we were able to define a multiplication law for Betti diagrams that respects the decomposition. Given the Betti diagram of any complete intersection, this new law allows us to write a simple pure diagram decomposition in terms of the degrees of the minimal generators for the complete intersection. This work was done as part of a Mathematical Sciences Research Institute summer graduate workshop in 2011. (Received September 07, 2013)

1095-13-152 **Youngsu Kim*** (kim455@purdue.edu), Department of Mathematics, Purdue University, 150 N. University Street, West Lafayette, IN 47907. *Quasi-Gorensteiness of Extended Rees Algebras.*
A ring having a canonical module is called quasi-Gorenstein if it is isomorphic to the canonical module. A quasi-Gorenstein ring is Gorenstein if and only if it is Cohen-Macaulay. There are rings which are quasi-Gorenstein, but not Cohen-Macaulay; hence they are not Gorenstein. We show that for some classes of extended Rees algebras, the quasi-Gorenstein property implies Gorensteinness. (Received September 07, 2013)

1095-13-159 **Emilie Dufresne** and **Jack Jeffries*** (jeffries@math.utah.edu). *How many invariants are needed to separate orbits?*
The study of separating invariants is a new trend in invariant theory. For a finite group acting linearly on a vector space, a separating set is a set of invariants whose elements separate the orbits of G. In some ways, separating sets often exhibit better behavior than generating sets for the ring of invariants. We investigate the least possible cardinality of a separating set for a given G-action. Our main result is a lower bound which generalizes the classical result of Serre that if the ring of invariants is polynomial then the group action must be generated by pseudoreflections. We find these bounds to be sharp in a wide range of examples. (Received September 07, 2013)

1095-13-165 **Catalin Ciuperca*** (catalin.ciuperca@ndsu.edu), North Dakota State University, Mathematics Department 2750, PO Box 6050, Fargo, ND 58108-6050. *Asymptotic relative multiplicities for a pair of ideals.* Preliminary report.

Let $J \subseteq I$ be a pair of ideals in a formally equidimensional local ring R. We discuss the asymptotic behavior of the multiplicity $f(n)$ of the R-module I^n/J^n. (Received September 08, 2013)

1095-13-176 **Louiza Fouli***, New Mexico State University, Las Cruces, NM 88003, and **Bruce Olberding**. *Reductions over rings with finite fields.* Preliminary report.

Let R be a Noetherian local ring with residue field k and let I be an ideal of R. When k is an infinite field there is a well understood notion of minimal reductions of I. However, when k is a finite field such reductions may not exist. We consider the case of one-dimensional local Cohen-Macaulay rings with finite residue field. We investigate conditions under which one can guarantee the existence of principal reductions and conditions that guarantee the absence of such reductions. This is joint work with Bruce Olberding. (Received September 08, 2013)

1095-13-185 **Sang Bum Lee*** (sblee@smu.ac.kr), Jongro-Gu, Honji-dong 7, Department of Mathematics, Sangmyung University, Seoul, 110-743, South Korea. *Modules over AW-domains.* Preliminary report.

We consider domains over which all absolutely pure modules are weak-injective. We find that such domains generalize certain properties over almost perfect domains and noetherian domains. By making use of this result, we answer two open problems concerning pre-Ptuefer domains. It is also shown that absolute purity and weak-injectivity are equivalent properties only in Dedekind domains. (Received September 08, 2013)

1095-13-200 **Uwe Nagel** and **Augustine O'Keefe*** (abok222@uky.edu). *Cellular resolutions of some artinian level monomial ideals.* Preliminary report.

Nagel and Reiner showed that a mixed subdivision of the dilated simplex $d\Delta_n$ supports a minimal cellular resolution of the d^{th} power of the maximal ideal $\mathfrak{m}$ in the ring $k[x_1, \ldots, x_n]$. In this talk we give a procedure on the mixed subdivision of $d\Delta_n$ resulting in a cell complex that supports a minimal free resolution of the ideal $\mathfrak{m} + \langle \mathbf{x}^{\mathbf{a}} \rangle$. (Received September 09, 2013)

1095-13-210 **Jack Jeffries**, **Jonathan Montaño*** (jhoniermon@gmail.com) and **Matteo Varbaro**. *Multiplicities of Classical Varieties.*

The j-multiplicity plays an important role in the intersection theory of Stückrad-Vogel cycles, while recent developments confirm the connections between the ϵ-multiplicity and equisingularity theory. In this talk, I will report joint work with Jack Jeffries and Matteo Varbaro, where we are able to compute the j-multiplicity of all the ideals defining rational normal scrolls by establishing a relationship between the j-multiplicity of an ideal and the degree of its fiber cone. We are also able to express the j- and ϵ-multiplicity of ideals defining determinantal varieties as the integral of a polynomial over a region. (Received September 09, 2013)

1095-13-217 **Ben Richert*** (brichert@calpoly.edu), Math Dept., Cal Poly, San Luis Obispo, CA 93407. *A proof of Evans Convexity Conjecture which shows that the competing definitions of Lex Plus Powers ideals lead to equivalent statements of the Eisenbud-Green-Harris and Lex Plus Powers conjectures.*

It is interesting to determine what sets of graded Betti numbers can occur for cyclic modules attaining a given Hilbert function. One approach is to restrict to modules whose annihilators contain a regular sequence with terms in prescribed degrees. The Eisenbud-Green-Harris (EGH) conjecture and the Lex Plus Powers (LPP) conjecture of Charalambous and Evans both predict that quotients of the so-called Lex Plus Powers ideals are extremal (in appropriate ways) among these modules. Lex Plus Powers ideals are monomial ideals containing a regular sequence of pure powers in specified degrees and whose other generators are as lex as possible. There is, however, some debate about whether or not the definition should require the identified regular sequence to be contained in the ideal minimally. The different versions of the definition give, on the face of it, different versions of EGH and LPP. We show that the competing versions of these conjectures are equivalent by way of a proof of Evans Convexity Conjecture which predicts the existence of certain Lex Plus Powers ideals by way of a convexity relation between a given Lex Plus Powers ideal and the lex ideal attaining the same Hilbert function. (Received September 09, 2013)

14 ► Algebraic geometry

1095-14-2 **Mark Gross*** (mgross@math.ucsd.edu), UCSD Mathematics, 9500 Gilman Drive, La Jolla, CA 92093-0112. *Applications of mirror symmetry.*

Mirror symmetry is a geometric phenomenon originally discovered by string theorists around 1990. It can be viewed as a kind of Legendre or Fourier transform which translates one kind of geometric problem (typically having to do with symplectic geometry) into another kind of geometric problem (typically having to do with complex geometry). I will discuss some recent applications of mirror symmetry to apparently diverse topics, such as deformation theory of singularities and cluster algebras. Underlying these applications is the notion of *theta functions*, a generalization of classical notion of theta function. The work I will discuss has been developed in various collaborations with P. Hacking, S. Keel, M. Kontsevich and B. Siebert. (Received September 08, 2013)

1095-14-21 **Mao-Ting Chien*** (mtchien@scu.edu.tw), Department of Mathematics, Soochow University, Taipei, 11102, Taiwan. *Singular points associated with weighted shift matrices.*

Let S be an n-by-n weighted shift matrix, and $F_S(t,x,y) = \det(tI_n + x\,\mathrm{Re}(S) + y\,\mathrm{Im}(S))$ be a ternary form associated with S. We investigate the number of singular points of the curve $F_S(t,x,y) = 0$, and show that the number of singular points of $F_S(t,x,y) = 0$ associated with a unitarily irreducible weighted shift matrix is at most $n(n-3)/2$. Furthermore, we verify the upper bound $n(n-3)/2$ is sharp for $4 \leq n \leq 7$. (Received July 30, 2013)

1095-14-34 **Dragos Oprea*** (doprea@math.ucsd.edu), 9500 Gilman Drive, La Jolla, CA 92103, and **Alina Marian** and **Rahul Pandharipande**. *The Chern classes of the Verlinde bundles.*

A formula for the first Chern class of the Verlinde bundle over the moduli space of smooth genus g curves is given. A finite-dimensional argument is presented in rank 2 using geometric symmetries obtained from strange duality, relative Serre duality, and Wirtinger duality together with the projective flatness of the Hitchin connection. A derivation using conformal-block methods is presented in higher rank. An expression for the first Chern class over the compact moduli space of curves is obtained. (Received August 20, 2013)

1095-14-35 **Thanh Quang Vu*** (vqthanh@math.berkeley.edu). *The Koszul property of pinched Veronese varieties.*

Let K be an arbitrary field. Let $n, d \geq 2$ be positive integers. Let $S = K[x_1, ..., x_n]$ be the polynomial ring in n variables. Let $V(n,d)$ be the set of all lattice points $\mathbf{b} = (b_1, ..., b_n)$ in $\mathbb{N}^n$ such that $\sum_{i=1}^n b_i = d$. Let $\Lambda = V(n,d) \setminus \mathbf{a}$ for some element $\mathbf{a} \in V(n,d)$. In this talk, we will prove that the semigroup ring $K[\Lambda]$ is Koszul unless $d \geq 3$ and $\mathbf{a} = (0, ..., 0, 2, d-2)$ or one of its permutations. This generalizes results of Caviglia, Conca, and Tancer. (Received August 30, 2013)

1095-14-53 **Elham Izadi***, Department of Mathematics, 9500 Gilman Drive, University of California, San Diego, La Jolla, CA 92093-0112. *The primitive cohomology of theta divisors.*

In joint work with Csilla Tamas and Jie Wang, we prove that the primitive cohomology of the theta divisor of an abelian fivefold satisfies the general Hodge conjecture, i.e., it is contained in the image of the cohomology of a threefold via a Gysin map. (Received August 24, 2013)

1095-14-54 **Nathan Ilten*** (nilten@math.berkeley.edu) and **Hendrik Suess**. *Torus Equivariant Vector Bundles.*

Klyachko has shown that there is an equivalence of categories between equivariant vector bundles on a toric variety X and collections of filtered vector spaces satisfying some compatibility conditions. I will discuss a generalization of this equivalence to the setting of T-equivariant vector bundles on a normal variety X endowed with an effective action of an algebraic torus T. Indeed, T-equivariant vector bundles on X correspond to collections of filtered vector bundles on a suitable quotient of X. This correspondence can be applied to show that T-equivariant bundles of low rank on projective space split, as well as to easily compute global vector fields on rational complexity-one T-varieties. (Received August 24, 2013)

1095-14-55 **James McKernan*** (jmckernan@math.ucsd.edu). *A geometric characterisation of toric varieties.*

We will describe a characterisation of toric varieties involving the geometry of log pairs (Received August 24, 2013)

1095-14-96 **Karl S Fredrickson***, karlfredrickson@gmail.com. *Mirror transitions and the Batyrev-Borisov construction.*

The definition of a geometric transition between two Calabi-Yau threefolds X and Y involves degenerating X to a singular variety X_0, then obtaining Y as a resolution of singularities of X. A familiar example of this is the class of conifold transitions, where the singular variety X_0 has isolated nodes as singularities and Y is a small resolution of X_0. The relationship between transitions and mirror symmetry was first described by D. Morrison, who proposed that if X and Y are related by a transition then their mirrors X^* and Y^* should also be related by a "mirror" geometric transition. In this talk I will discuss how transitions which are induced by toric morphisms, and their mirror transitions, could be related to the Batyrev-Borisov mirror symmetry construction in a relatively natural way. I will also talk about the details of two example cases that have been fully worked out. (Received September 01, 2013)

1095-14-100 **Vladimir Baranovsky*** (vova786@gmail.com), 340 Rowland Hall, UC Irvine, Irvine, CA 92617. *Poisson deformation of coherent sheaves.*

Let X be a smooth algebraic variety with an algebraic Poisson bivector P, and F a coherent sheaf on X. We present some old and new results on the problem of determining conditions when F deforms to a module over a deformation quantization coming from P. (Received September 02, 2013)

1095-14-129 **Xi Chen*** (xic@ualberta.ca), Department of Mathematics, University of Alberta, Edmonton, Alberta T6G 2G1, Canada. *On Vojta's $1+\varepsilon$ Conjecture.*

I will talk about a geometric proof of Vojta's $1+\varepsilon$ conjecture, following an idea of M. McQuillan. (Received September 05, 2013)

1095-14-143 **Dan Bates**, **David Eklund** and **Chris Peterson*** (peterson@math.colostate.edu). *Residual intersections and Chern numbers of irreducible varieties.*

Consider a smooth variety of dimension n with Chern classes $c_0, \ldots, c_n$. Many well known invariants of a smooth variety can be expressed in terms of the intersection numbers of these Chern classes (i.e. in terms of the degrees of monomials in the c_i). Computation of these numbers is closely related to residual intersection. This talk will illustrate how this connection can be exploited to compute several invariants of the variety. (Received September 06, 2013)

1095-14-186 **Aravind Asok*** (asok@usc.edu), 3620 S Vermont Ave KAP 104, Los Angeles, CA 90027, and **Jean Fasel**. *Vector bundles on smooth affine varieties.*

I will discuss joint work with Jean Fasel (Essen) regarding splitting problems for vector bundles on smooth affine varieties of rank below the dimension. (Received September 09, 2013)

1095-14-193 **Andrew W. Macpherson*** (a.macpherson10@imperial.ac.uk). *Skeleta of degenerations and of non-Archimedean analytic spaces.*

I'll present a general theory of "tropical schemes", or *skeleta*, which is based on reversing the correspondence which associates to a "tropical object" its semiring of convex piecewise-affine functions; in this way, we can recover well-known classical constructions using semiring theory. For example, we can recover the dual intersection complexes associated to degenerations of varieties as skeleta.

I'll also show how skeleta fit into the context of non-Archimedean geometry. (Received September 09, 2013)

1095-14-197 **Ziv Ran*** (ziv.ran@ucr.edu), Big Springs Road, Riverside, CA 92521. *Deformations of Poisson manifolds.*

We prove unobstructed deformations for compact even-dimensional Kaehlerian Poisson manifolds whose Poisson tensor degenerates nicely along a normal-crossings divisor, refining results of Goto and Hitchin (valid without the normal-crossing hypothesis). (Received September 09, 2013)

15 ► Linear and multilinear algebra; matrix theory

1095-15-260 **Daniel P Brice*** (dpb0006@auburn.edu), Department of Mathematics and Statistics, Parker Hall 221, Auburn University, AL 36849. *Constructions on zero product determined algebras.*

Abstract: An algebra is called zero product determined if whenever a bilinear map $\varphi : A \times A \longrightarrow A$ satisfies (for all $a_1, a_2 \in A$) $\varphi(a_1, a_2) = 0$ whenever $a_1 a_2 = 0$ there is a linear map $\tilde{\varphi} : A^2 \longrightarrow A$ satisfying (for all $a_2, a_2 \in A$) $\tilde{\varphi}(a_1 a_2) = \varphi(a_1, a_2)$. We prove several results concerning constructions on zero product algebras. Among these,

that the tensor product of two zero product determined algebras is zero product determined and that the direct sum of (arbitrarily many) algebras is zero product determined if and only if each component summand is zero product determined. (Received September 10, 2013)

1095-15-281 **Kourosh Modarresi***, Kourosh Modarresi, Stanford, CA. *Mathematical Challenges in "Modern Data" Analysis.*

Modern data introduces unprecedented challenges for the science of "Data Analysis". The main challenge is not necessarily resulting from the size of the modern data, but is a consequence of its unique features. As a result of these unique properties, direct application of old mathematical models and algorithms of "Machine Learning", "Mathematical Modelling", "Statistical Analysis" and other analytical algorithms may be proven to be of little use, if any at all. In this work, I will discuss about theses difficulties of analyzing this type of data and then I look into some of the solutions. (Received September 11, 2013)

16 ► Associative rings and algebras

1095-16-18 **Jiarui Fei*** (jiarui@ucr.edu). *Vanishing cycles and Cluster transformation.*

For a quiver with potential, we can associate a vanishing cycle to each representation space. If there is a nice torus action on the potential, the vanishing cycles can be expressed in terms of truncated Jacobian algebras. We study how these vanishing cycles change under the mutation of Derksen-Weyman-Zelevinsky. The wall-crossing formula leads to a categorification of quantum cluster algebras under the assumption of existence of certain potential. As a consequence, the strong positivity of the corresponding cluster algebra is boiled down to the purity of the cycles. This is a special case of A. Efimov's result, but our approach is more concrete and down-to-earth. We also obtain a formula relating the representation Grassmannians under sink-source reflections. You will see some examples. (Received July 09, 2013)

1095-16-127 **Jonathan Brundan*** (brundan@uoregon.edu), Department of Mathematics, Eugene, OR 97403. *Tensor product categorifications and the super Kazhdan-Lusztig conjecture.*

I will talk about some recent joint work with Ben Webster and Ivan Losev. We give a new proof of the 'super Kazhdan-Lusztig conjecture' for the general linear Lie superalgebra which I proposed in 2003. The conjecture was finally proved a couple of years ago by Cheng, Lam and Wang by a different method. Our new approach is based crucially on application of the uniqueness of tensor product categorificaitons established recently by my coauthors. It allows us to prove moreover that the blocks admit a graded version which is Koszul. (Received September 05, 2013)

1095-16-128 **Jonathan Brundan*** (brundan@uoregon.edu), Department of Mathematics, Eugene, OR 97403. *Homological properties of finite type quiver Hecke algebras.*

I will talk about some joint work with Alexander Kleshchev and Peter McNamara. We give an elementary algebraic way to realize the irreducible representations of finite type quiver Hecke algebras (KLR algebras) based on a theory of standard and proper standard modules. These two sorts of standard modules categorify the PBW and dual PBW bases, respectively. They have nice homological properties similar to those of a quasi-hereditary algebra. Previously the results had been obtained by Kato in simply-laced types via some geometry. (Received September 05, 2013)

1095-16-162 **Georgia Benkart**, **Nicolas Guay*** (nguay@ualberta.ca), **Ji Hye Jung**, **Seok Jin Kang** and **Stewart Wilcox**. *Quantum walled Brauer-Clifford superalgebras.* Preliminary report.

Walled Brauer algebras appeared about twenty years ago as centralizer algebras for the action of $\mathfrak{gl}_n(\mathbb{C})$ on the mixed tensor space $(\mathbb{C}^n)^{\otimes r} \otimes (\mathbb{C}^{n*})^{\otimes s}$. They admit analogs for the corresponding quantized enveloping algebra. Recently, S.J. Kang and J.H. Jung have investigated new walled Brauer(-Clifford) superalgebras which are centralizers for the action of the Lie superalgebra of type Q on the mixed tensor superspace $(\mathbb{C}(n|n))^{\otimes r} \otimes (\mathbb{C}(n|n)^*)^{\otimes s}$. Quantum analogs of those superalgebras will be presented along with a few results about them: e.g. centralizer property, almost cellularity. A connection with new q-Schur superalgebras of type Q will also be discussed. (Received September 08, 2013)

1095-16-183 **Akaki Tikaradze*** (tikar06@gmail.com), Department of Mathematics, University of Toledo, Toledo, OH 43606. *On generic quantum Hamiltonian reductions.* Preliminary report.

Many important algebras in representation theory can be realized as quantum Hamiltonian reductions. We will discuss a general geometric setting which yields certain ring theoretic properties for corresponding quantum Hamiltonian reductions for generic parameter values. (Received September 08, 2013)

1095-16-221 **A P Ellis*** (ellis@uoregon.edu) and **A D Lauda**. *An odd categorification of quantum sl(2).*

We categorify covering quantum sl(2) using a diagrammatic super-2-cateogory. This super-2-category admits a 2-representation in which it acts on cyclotomic quotients of odd nilHecke algebras. (Received September 09, 2013)

1095-16-254 **Emily Norton*** (emn37@case.edu). *Symplectic reflection algebras of elementary abelian p-groups.*

I will describe the algebraic structure and representation theory of the symplectic reflection algebra in characteristic p associated to an elementary abelian p-group. While some constructions from characteristic 0 fail in this setting, these algebras happen to have a presentation as Ore extensions over a commutative subring, and this makes them amenable to study. There are also interesting connections to combinatorics of the symmetric group. (Received September 10, 2013)

17 ► Nonassociative rings and algebras

1095-17-33 **David Hill*** (dehill@virginia.edu), **Sean Clark** and **Weiqiang Wang**. *Quantum Shuffles, Canonical Bases, and Simple Lie Superalgebras.*

We study the embedding of the (half) quantum group of a simple Lie superalgebra of basic type into a quantum shuffle superalgebra.

First, we establish a Lyndon theory for the image of the embedding, generalizing the results of Lalonde-Ram and Leclerc. Next, we construct a family of PBW-type bases, and give a direct combinatorial proof that these bases are orthogonal with respect to a non-degenerate bilinear form in all but finitely many cases. Finally, we prove the existence of a bar invariant basis obtained by triangular change from the PBW basis, and analyze the cases where this basis is canonical (i.e. almost orthonormal with respect to the bilinear form).

The orthogonality result for the PBW bases is new even for simple Lie algebras, and leads to a self-contained proof of the existence of canonical bases. (Received August 20, 2013)

1095-17-83 **David Hill*** (dehill@virginia.edu) and **Weiqiang Wang**. *Categorification of Quantum Kac-Moody Superalgebras.*

We categorify (half) quantum Kac-Moody superalgebras with nonisotropic odd roots. (Received August 30, 2013)

1095-17-104 **Zhaobing Fan** and **Yiqiang Li***, 244 Mathematics Building, Buffalo, NY 14260. *A geometric setting for quantum osp(1—2).*

I will present a geometric construction (weak categorification) of quantum osp(1—2) and its tensor products of simple modules. I will discuss an interaction between various classes of quantum groups observed from the construction. (Received September 03, 2013)

1095-17-141 **Sean I Clark*** (sic5ag@virginia.edu), **David Hill** and **Weiqiang Wang**. *A canonical basis for covering quantum groups.*

Motivated by the categorification of half a Kac-Moody quantum supergroup by two of the authors, we introduce the notion of a covering quantum group which unites the representation theory of Kac-Moody quantum supergroups with the representation theory of the corresponding Kac-Moody quantum groups. We show that these covering quantum groups admit canonical bases. (Received September 06, 2013)

1095-17-153 **Michael K. Lau*** (michael.lau@mat.ulaval.ca), Département de mathématiques, Pavillon Vachon (local 1056), 1045 av. de la Médecine, Québec, QC G1V0A6, Canada. *Representations of twisted current algebras.*

A number of recent papers have used evaluation modules to describe the finite-dimensional representation theory of various generalizations of affine Lie algebras (derived algebras modulo their centres). We explain how these ideas can be combined with techniques from descent theory to give a unified treatment of representations of two

of the most compelling such generalizations, equivariant map algebras and twisted forms of current algebras. (Received September 07, 2013)

1095-17-156 **Sachin Gautam*** (sachin@math.columbia.edu), Department of Mathematics, Columbia University, 2990 Broadway, New York, NY 10027, and **Valerio Toledano Laredo** (v.toledanolaredo@neu.edu), Department of Mathematics, Northeastern University, 360 Huntington Avenue, Boston, MA 02115. *Tensor isomorphisms between Yangians and quantum loop algebras.*

The Yangian and the quantum loop algebra of a simple Lie algebra arise naturally in the study of the rational and trigonometric solutions of the Yang–Baxter equation, respectively. The aim of this talk is to establish an explicit relation between these two Hopf algebras. More precisely, we will show that a certain subcategory of finite–dimensional representations of the Yangian is isomorphic, as a tensor category, to the category of finite–dimensional representations of the quantum loop algebra.

The isomorphism between these two categories is governed by the monodromy of an abelian difference equation. Moreover, the twist relating the tensor products is a solution to an abelian version of the qKZ equations of Frenkel and Reshetikhin. (Received September 07, 2013)

1095-17-188 **Dimitar Grantcharov*** (grandim@uta.edu), Department of Mathematics, UT Arlington, Arlington, TX 76019, and **Vera Serganova**. *Weight modules of algebras of twisted differential operators on the projective space.*

In this talk we will discuss blocks of categories of weight and generalized weight modules of algebras of twisted differential operators on $\mathbb{P}^n$. Necessary and sufficient conditions for these blocks to be tame and to be Koszul are provided. We also establish equivalences of categories between these blocks and categories of bounded and generalized bounded weight $\mathfrak{sl}(n+1)$-modules in the cases of nonintegral and singular central character. (Received September 09, 2013)

1095-17-196 **Andrea Appel*** (andrea@math.huji.ac.il), Einstein Institute of Mathematics, Edmond J. Safra Campus, Givat Ram, 91904 Jerusalem, Israel. *Quasi-Coxeter categories for symmetrizable Kac-Moody algebras.*

In 2005, V. Toledano Laredo proved that the monodromy of the Casimir connection of a simple Lie algebra $\mathfrak{g}$ is described by the quantum Weyl group operators of the quantum group $U_\hbar\mathfrak{g}$. His proof relies upon the notion of a quasi–Coxeter quasitriangular quasibialgebra, which is informally a bialgebra carrying actions of a given generalized braid group and Artin's braid groups on the tensor products of its modules. In this talk, I will give a brief overview of the strategy to extend these results when $\mathfrak{g}$ is an arbitrary symmetrizable Kac–Moody algebra, based upon a generalization of the notion of a quasi–Coxeter algebra at a categorical level. This talk is based on a joint work with V. Toledano Laredo (arxiv:1212.6720). (Received September 09, 2013)

1095-17-199 **N. Manning*** (nmanning@uottawa.ca), Dept. of Mathematics and Statistics, 585 King Edward Ave, Ottawa, Ontario K1N6Y7, Canada, and **E. Neher** and **H. Salmasian**. *Global and Local Weyl Modules.* Preliminary report.

A family of infinite-dimensional modules called global Weyl modules was defined and studied by Chari and Pressley over loop algebras $\mathfrak{g} \otimes \mathbf{C}[t, t^{-1}]$, where $\mathfrak{g}$ is a simple complex finite-dimensional Lie algebra. This talk gives an overview of some recent results on these modules. (Received September 09, 2013)

18 ► Category theory; homological algebra

1095-18-70 **Ivan Loseu***, 360 Huntington Avenue, Boston, MA 02115, and **Ben Webster**. *Uniqueness of tensor product categorifications.*

This talk is based on http://arxiv.org/abs/1303.1336. We propose a definition of a tensor product of several Kac-Moody categorifications. We prove that the product is unique provided the factors are minimal categorifications. (Received August 27, 2013)

1095-18-122 **Yin Tian*** (yintian@usc.edu), 3620 S VERMONT AVE, KAP 104, Los Angeles, CA 90089. *A diagrammatic categorification of a Clifford algebra via contact topology.*

Khovanov gave a graphical calculus for a categorification of a Heisenberg algebra. In this talk we describe a diagrammatic categorification of a Clifford algebra and its Fock space representation via differential graded categories. The motivation is from the *contact categories* $\mathcal{C}(\Sigma)$ of infinite strips Σ introduced by Honda which describe contact structures on $\Sigma \times [0, 1]$. (Received September 05, 2013)

1095-18-195 **Matt Hogancamp*** (mhoganca@indiana.edu). *A Quasi-Local Approach to Link Homology.*

There exist many categorifications of quantum link invariants, but as yet none of their "colored" versions are functorial under 4-dimensional link cobordisms. In this talk I propose a new categorification of the colored Jones polynomial which is likely to be functorial. The construction uses a new, quasi-idempotent chain complex which categorifies a multiple of the Jones-Wenzl projector. (Received September 09, 2013)

1095-18-203 **Jacob R West*** (west@math.ucr.edu), Department of Mathematics, University of California, Riverside, 900 University Ave., Riverside, CA 92521. *Higher Auslander-Reiten theory.*

Auslander-Reiten theory is an important tool in studying representations of finite dimensional algebras. In this talk, we introduce the basic notions of Auslander-Reiten theory in stable $(\infty, 1)$-categories and establish criteria for the existence of Auslander-Reiten sequences in this setting. (Received September 09, 2013)

1095-18-208 **Hugo Vincent Bacard*** (hbacard@uwo.ca). *Local model structure for co-Segal categories.*

Given a monoidal model category $\mathcal{M}$, we introduced a theory of *co-Segal $\mathcal{M}$-categories* which are weakly enriched categories over $\mathcal{M}$. They are defined as $\mathcal{M}$-valued lax 2-functors satisfying some homotopy conditions. Examples of such categories emerge naturally when we consider homotopy transfer of algebraic structure. The homotopy theory of co-Segal categories is build within the more general objects consisting of co-Segal precategories. But so far we only have the *fibred model structure*, which is not satisfactory since a weak equivalence therein must induce an isomorphism on the set of objects. In this talk, after exposing the theory with some examples, I will present a new model structure for co-Segal precategories, which is somehow the 'correct' one. This new model structure has better properties and one has that fibrant objects are co-Segal categories. (Received September 09, 2013)

1095-18-228 **Zsuzsanna Dancso***, zsuzsi@math.toronto.edu, and **Anthony Licata**. *Bipartite algebras and a categorification of the cut- and flow lattices of graphs.* Preliminary report.

We study a class of finite dimensional Koszul algebras ("bipartite algebras") associated to bipartite graphs. We discuss their duality properties and representation theory, as well as an application to the categorification of the cut and flow lattices of graphs. We suspect that bipartite algebras also arise naturally in several other contexts. This is work in progress with Anthony Licata. (Received September 09, 2013)

1095-18-235 **Raphaël Rouquier*** (rouquier@math.ucla.edu), Département of Mathematics, Box 951555, Los Angeles, CA 90095-1555. *Tensor products of 2-representations.*

We will explain the construction of tensor products of 2-representations of Kac-Moody algebras on A-infinity categories. (Received September 10, 2013)

1095-18-250 **Ivan Dungan*** (gdungan@math.fsu.edu), Florida State University, Department of Mathematics, 1017 Academic Way, 208 Love Building, Tallahassee, FL 32306. *n-Butterflies.* Preliminary report.

We will continue the work of Behrang Noohi's that weak morphisms between 2-groups can be modeled by butterflies. First, we will discuss reduced crossed complexes, which are an algebraic model of infinity groups, and their inherited homotopy theory. Restricting to reduced n-crossed complexes, we will formulate a model of the weak morphisms between n-groups. (Received September 10, 2013)

1095-18-259 **Radmila Sazdanovic*** (rsazdanovic@math.ncsu.edu), Department of Mathematics, North Carolina State University, PO Box 8205, Raleigh, NC 27695, and **Mikhail Khovanov**. *Categorification of the Chebyshev polynomials.* Preliminary report.

We introduce a diagrammatic categorification of the one-variable polynomial ring Z[x] which leads to categorification of some basic special functions such as Chebyshev polynomials. (Received September 10, 2013)

19 ► K-theory

1095-19-68 **Bruce A. Magurn*** (magurnba@miamioh.edu). *Generalized euclidean group rings.*

A ring is generalized euclidean (GE) if Euclid's algorithm works for unimodular lists of elements. Expanding on results of Bob Oliver, we provide many finite groups G whose integral group rings are GE and many that are not. Oliver's method introduces a new layer between elementary and special linear groups over commutative rings. (Received August 27, 2013)

1095-19-170 **Mona Mocanasu*** (mmocanas@msudenver.edu), MSU Denver, Mathematical And Computer Sciences Dep., P.O. Box 173362, Campus Box 38, Denver, CO 80217. *A Bivariant Theory for Quasi-Projective Schemes.*

In the *"Categorical Framework for the Study of Singular Spaces"* W. Fulton and R. MacPherson describe how bivariant theories can be used to study singular topological spaces. We modify and extend their approach to construct a bivariant theory that connects singular homology of quasi-projective schemes to cohomology with support for smooth pairs of schemes. This general construction is consistent with the known cases; for example, it connects singular Chow groups $CH_*(X)$ with the Operational Chow Groups for closed embeddings, $A^*(X \hookrightarrow Y)$.

We describe the most general type of pull-back and push-forward maps and list the conditions required for the existence of both these structures on a given theory. Moreover, our construction gives a compatible structure of higher Chern classes, fact that allows us to study the problem of a general Riemann-Roch theorem for singular homologies. (Received September 08, 2013)

1095-19-237 **Mona Merling*** (mmerling@math.uchicago.edu). *Equivariant algebraic K-theory.* Preliminary report.

In the early 1980's, Dress and Kuku, and Fiedorowicz, Hauschild and May introduced space level equivariant versions of the plus and Q constructions in algebraic K-theory. However, back then, the methods did not allow for nontrivial group action on the input ring or category. We generalize these definitions to the case in which a finite group G acts nontrivially on a ring (or an exact or Waldhausen category) and we show how to construct a genuine equivariant K-theory spectrum with good properties from a G-ring. An example of interest is that of a Galois extension.

The equivariant constructions rely on finding categorical models for classifying spaces of equivariant bundles (a joint project with Guillou and May) and the use of equivariant infinite loop space machines such as the one developed by Guillou and May, or the equivariant version of Segal's machine. The comparison of these machines, which will allow their interchangeable use in algebraic K-theory constructions, is a joint project with May and Osorno. New ideas are needed since, among other things, the comparison theorem of May and Thomason fails equivariantly. (Received September 10, 2013)

1095-19-239 **Matthew Morrow*** (morrow@math.uni-bonn.de). *Continuity of topological cyclic homology.*

A problem in K-theory dating back to work of Suslin and Panin in the 1980s is that of the continuity of K-theory: given an ideal I of a ring A, what is the relationship between the K-theory of A and that of A/I^r, for all $r > 0$? In particular, when is $K(A)$ homotopy equivalent to $\mathrm{holim}_r K(A/I^r)$, perhaps after taking profinite completions?

Analogous questions may be asked for Hochschild and cyclic homology, and their topological counterparts. I will describe joint work with Bjørn Dundas in which it is shown that topological cyclic homology is indeed continuous in many expected cases. (Received September 10, 2013)

1095-19-256 **Andrew J Blumberg*** (blumberg@math.utexas.edu), Department of mathematics, University of Texas, Austin, TX 78712, and **Michael A Mandell**, Department of mathematics, Indiana University, Bloomington, IN 47405. *The stable homotopy theory of cyclotomic spectra.*

To be filled in. (Received September 10, 2013)

20 ► Group theory and generalizations

1095-20-93 **Daniele Rosso*** (drosso@uottawa.ca). *The Mirabolic Hecke Algebra.*

Several important algebras in representation theory, like Iwahori-Hecke algebras of Weyl groups and Affine Hecke Algebras, can be realized as convolution algebras on flag varieties. Some of these constructions can be carried over to the 'mirabolic' setting to obtain other interesting algebras. We will discuss the convolution algebra of GL(V)-invariant functions on triples of two flags and a vector, which was first described by Solomon, and its connections to the cyclotomic Hecke algebras of Ariki and Koike. (Received September 01, 2013)

1095-20-133 **Justin R. Hughes*** (hughes@math.colostate.edu), Colorado State University, Department of Mathematics, 101 Weber Building, Fort Collins, CO 80523. *Representations Arising from an Action on D-neighborhoods of Cayley Graphs.*

Given G a finite group and a generating set, one can construct the Cayley Graph. With a set D comprised of nonnegative integers one can construct a D-neighborhood complex from the Cayley Graph. This neighborhood

complex is a simplicial complex and thus it is natural to form an associated chain complex. The group G acts naturally on the chain complex and this leads to an action on the homology of the chain complex. These group actions give rise to several representations of G. This work uses tools from group theory, representation theory and homological algebra to further our understanding of the interplay between generated groups (i.e. a group together with a set of generators), corresponding representations on their associated D-neighborhood complexes, and the homology of the D-neighborhood complexes. (Received September 06, 2013)

1095-20-198 **Victor Ostrik*** (vostrik@uoregon.edu), Department of Mathematics, University of Oregon, Eugene, OR 97403-1222. *Count of finite dimensional irreducible modules over finite W-algebras.*

I will report on my joint work with I.Losev. We give a general conjecture on the parametrization of finite dimensional irreducible modules over finite W-algebras and prove it in the case integral central character. (Received September 09, 2013)

22 ► Topological groups, Lie groups

1095-22-85 **Mark Colarusso***, colaruss@uwm.edu, and **Sam Evens**. *Eigenvalue Coincidences and K-orbits on the flag variety.*

This talk is based on joint work with Sam Evens which relates the Gelfand-Zeitlin integrable system on $gl(n, C)$ to orbits of $K = GL(n-1, C) \times GL(1, C)$ on the flag variety of $gl(n, C)$. For an n by n matrix $x \in gl(n, C)$, let x_{n-1} be the n-1 by n-1 matrix in the upper left corner of x. We study the variety $X(j)$ consisting of matrices x such that x and x_{n-1} share at least j eigenvalues in common counting repetitions. We show that $X(j)$ is an equidimensional variety of codimension j. The irreducible components of $X(j)$ are given by the K-saturation of Borel subalgebras which generate K-orbits of codimension j in the flag variety of $gl(n, C)$. (Received August 30, 2013)

1095-22-207 **Bruce Fontaine***, bfontain@math.cornell.edu, and **Joel Kamntizer** and **Greg Kuperberg**. *Webs, spiders and the affine Grassmannian.*

Let G be a simple algebraic group. We examine two different bases for the space of invariants of a tensor product of representations. The first is the web basis and it is given by labeled trivalent graphs called webs. Using the geometric Satake correspondence, the irreducible components of a certain variety of points in the affine Grassmannian also give basis for this space, which we call the Satake basis. From a web, we construct the web variety, a set of configurations of points in the affine Grassmannian. This allows us to deduce that the change of basis is upper unitriangular and not the identity. (Received September 09, 2013)

1095-22-231 **Alissa S. Crans*** (acrans@lmu.edu), **Sandy Ganzell** and **Blake Mellor**. *The Forbidden Number of a Knot.*

Every classical or virtual knot is equivalent to the unknot via a sequence of extended Reidemeister moves and the so-called forbidden moves. The minimum number of forbidden moves necessary to unknot a given knot is a new invariant we call the *forbidden number*. We relate the forbidden number to several known invariants, and calculate bounds for some classes of virtual knots. (Received September 10, 2013)

28 ► Measure and integration

1095-28-94 **Michel L. Lapidus** and **John A. Rock*** (jarock@csupomona.edu), Mathematics and Statistics, Cal Poly Pomona, 3801 W Temple Ave, Pomona, CA 91768, and **Darko Zubrinic**. *Box-counting fractal strings and complex dimensions of bounded sets.* Preliminary report.

Motivated by the theory of complex dimensions for ordinary fractal strings (bounded open subsets of the real line) developed by Lapidus, van Frankenhuijsen and their collaborators, the notion of box-counting fractal strings provides a foundation for a theory of complex dimensions for bounded sets in some Euclidean space. Discussed in this talk are definitions and properties of box-counting fractal strings, box-counting zeta functions, and box-counting complex dimensions. Specific topics include the equality between the abscissa of convergence of the box-counting zeta function of a bounded set and its upper box-counting dimension as well as an example of a closed form for the box-counting zeta function of a self-similar set satisfying a separation condition. (Received September 02, 2013)

1095-28-146 **Michel L Lapidus*** (lapidus@math.ucr.edu), University of California, Department of Mathematics, Riverside, CA 92521-0135, **Goran Radunovic** (goran.radunovic@fer.hr), University of Zagreb, Department of Applied Mathematics, Unska 3, 10000 Zagreb, Croatia, and **Darko Zubrinic** (darko.zubrinic@fer.hr), University of Zagreb, Department of Applied Mathematics, Unska 3, 10000 Zagreb, Croatia. *Fractal Zeta Functions and Complex Dimensions: A General Higher-Dimensional Theory.*

We will give some sample results from the new theory developed in the forthcoming joint research monograph (by the three authors of this abstract), entitled "Fractal Zeta Functions: Higher-Dimensional Theory of Complex Dimensions", and explain its connections with the earlier one-dimensional theory of complex dimensions developed, in particular, in the research monograph (by M. L. Lapidus and M. van Frankenhuijsen) entitled "Fractal Geometry, Complex Dimensions and Zeta Functions: Geometry and Spectra of Fractal Strings" (Springer Research Monographs, Springer, New York, 2013; 2nd rev. and enl. edn. of the 2006 edn.). In particular, to an arbitrary compact subset A of the N-dimensional Euclidean space (or, more generally, to any relative fractal drum), we will associate new distance and tube zeta functions, as well as discuss their basic properties, including their holomorphic and meromorphic extensions, and the nature and distribution of their poles (or 'complex dimensions'). We will also show that the abscissa of convergence of each of these fractal zeta functions coincides with the upper box (or Minkowski) dimension of the underlying compact set A, and that the associated residues are intimately related to the (possibly suitably averaged) Minkowski content of A. (Received September 07, 2013)

1095-28-149 **Guy C. David*** (guydavid@math.ucla.edu). *Bi-Lipschitz pieces between manifolds.* Preliminary report.

A well-known class of questions asks the following: If X and Y are metric measure spaces and $f : X \to Y$ is a Lipschitz mapping whose image has positive measure, then must f have large pieces on which it is bi-Lipschitz? Building on methods of David (who is not the present speaker!) and Semmes, we will discuss work in preparation which answers this question for Lipschitz mappings between certain types of metric manifolds with the same dimensions. These manifolds need not be embeddable in any Euclidean space. To prove the result, we use some facts on Gromov-Hausdorff convergence of manifolds and a topological theorem of Bonk and Kleiner. This also yields a new proof of the uniform rectifiability of some metric manifolds. (Received September 07, 2013)

1095-28-206 **Michel L Lapidus** (lapidus@math.ucr.edu), Mathematics Department, Riverside, CA 92521, **Erin PJ Pearse*** (epearse@calpoly.edu), Mathematics Department, San Luis Obispo, CA 93405, and **Steffen Winter** (steffen.winter@kit.edu), Institute of Stochastics, KIT, Kaiserstr. 89-93, 76133 Karlsruhe, Germany. *Fractal tube formulas: curvature and measurability.*

I will describe a method for computing the tubular formula (a formula for the volume of the tubular neighbourhood) for lattice and nonlattice self-similar fractals. The focus is on Minkowski measurability properties, including recent work on Gatzouras' conjecture that a self-similar is Minkowski measurable if and only if it is of nonlattice type. (Received September 09, 2013)

1095-28-257 **Hrant Hakobyan*** (hakobyan@math.ksu.edu), 138 Cardwell Hall, Department of Mathematics, Kansas State University, Manhattan, KS 66505, and **Marshall Williams** (mcwill@math.ksu.edu), 138 Cardwell Hall, Department of Mathematics, Kansas State University, Manhattan, KS 66506. *Frequency of Dimension Distortion.* Preliminary report.

We study the frequency of distortion of Hausdorff dimension in families of Ahlfors regular spaces under quasisymmetric and more general classes of mappings, such as mappings of finite distortion. (Received September 10, 2013)

30 ► Functions of a complex variable

1095-30-75 **Xiangdong Xie*** (xiex@bgsu.edu), Department of Mathematics and Statistics, Bowling Green State University, Bowling Green, OH 43403. *Rigidity of quasiconformal maps on Carnot groups.*

A Carnot Lie algebra $\mathcal{N} = V_1 \oplus \cdots \oplus V_r$ is said to have reducible first layer if there is a non-trivial proper linear subspace $W \subset V_1$ such that $A(W) = W$ for every graded automorphism of $\mathcal{N}$.

Let $K \geq 1$ and $C > 0$. A bijection $F : X \to Y$ between two metric spaces is called a (K, C)-quasi-similarity if

$$\frac{C}{K}\, d(x, y) \leq d(F(x), F(y)) \leq C\, K\, d(x, y)$$

for all $x, y \in X$. We say that a Carnot group N is *quasisymmetrically rigid* if every η-quasisymmetric map is a (K, C)-quasi-similarity, where K is a constant depending only on η.

We show the following:

Theorem. Let N be a 2-step Carnot group or a non-rigid Carnot group. If the first layer of its Lie algebra is reducible, then N is quasisymmetrically rigid. Furthermore, the Lie algebra of a non-rigid Carnot group has reducible first layer unless it is one of the following:
(1) it is a Euclidean group;
(2) it is a suitable quotient of the direct product of the same Heisenberg group;
(3) it is a suitable quotient of the direct product of the same complex Heisenberg group. (Received August 28, 2013)

1095-30-120 **John A. Simanyi*** (simanyi@math.ucr.edu). *Hyperbolic construction of Cantor sets.*
In this talk, we develop a construction of the ternary Cantor set within the context of Gromov hyperbolic geometry. Unlike the standard construction, where one proceeds by removing middle-third intervals, our construction utilizes the collection of the removed intervals. More precisely, we first hyperbolize (in the sense of Gromov) the collection of the removed middle-third open intervals; then, we define a visual metric on its boundary at infinity. The resulting metric space is isometric to the Cantor set. (Received September 04, 2013)

1095-30-150 **Kyle Kinneberg*** (kkinneberg@math.ucla.edu). *Quasi-Möbius Group Actions on Fractal Metric Spaces.*
The metric structure of boundaries of Gromov hyperbolic spaces have played an important motivating role for techniques in the analysis of metric spaces. In particular, uniformization questions about boundaries of hyperbolic groups are closely related to the analysis of metric spaces on which there is some type of expanding dynamics. In this talk, we will discuss a rigidity theorem for certain expanding quasi-Möbius group actions on fractal metric spaces. At the center of its proof is a discrete length-volume inequality for topological cubes. We will present a few extensions of this inequality that could be useful more generally in the analysis of metric spaces. (Received September 07, 2013)

1095-30-168 **Zair Ibragimov*** (zibragimov@fullerton.edu), 800 N State College Blvd., Fullerton, CA 92831. *Symmetric Product of Metric Spaces.*
The symmetric product of topological spaces were first introduced and studied by K. Borsuk and S. Ulam in 1931. For a metric space X, the nth symmetric product X(n) is the set of all subsets of X of cardinality less or equal to n endowed with the Hausdorff metric. In this talk I will discuss some results of K. Borsuk and S. Ulam as well as of R. Bott on the third symmetric product of a line and a circle and present some new results. (Received September 08, 2013)

1095-30-212 **Mario Bonk*** (mbonk@math.ucla.edu), Dept. of Mathematics, UCLA, Los Angeles, CA 90095. *Quasisymmetric rigidity of Sierpinski carpets.*
While Sierpinski carpets are topologically very flexible, surprising rigidity phenomena emerge if one considers their quasisymmetric homeomorphisms. In my talk I will give a survey on recent results in this area. The carpets considered are self-similar and often arise in dynamical contexts as limit sets of a Kleinian groups or Julia sets of a rational maps. (Received September 09, 2013)

33 ► Special functions

1095-33-38 **Richard A. Askey*** (askey@math.wisc.edu). *Some useful positive sums and integrals.* Preliminary report.
Some older and some newer examples of positive sums of Jacobi polynomials and integrals of Bessel functions will be described, and a few applications will be mentioned. (Received August 22, 2013)

1095-33-194 **Herbert K.W. Heyer*** (herbert.heyer@uni-tuebingen.de). *Hypergroup structures on the unit disk.*
Hypergroups are locally compact spaces on which the bounded measures convolve as in the group case. On the unit disk D a convolution can be introduced via disk polynomials such that D becomes a commutative (compact) hypergroup with a discrete dual.A generalized Fourier analysis for D leads to the study of hypergroup and measure algebras, also to applications to random walks in D. (Received September 09, 2013)

34 ► Ordinary differential equations

1095-34-160 **Lisette G. de Pillis*** (depillis@g.hmc.edu), Department of Mathematics, Harvey Mudd College, 301 Platt Blvd., Claremont, CA 91711. *Classroom Module for Mathematical Modeling of the AIDS Epidemic.*

Using the AIDS epidemic in the U.S. as a motivating topic, we have developed a classroom module that brings students through the process of model building using ODEs, numerical ODE system solutions, and model refinement. Finding model-based research literature that is still accessible to the student is useful in creating projects with relevant applications. This project was developed using a paper by J.R. Thompson and K.W. Go that was published in 1989, when much about AIDS was still unknown. It is interesting to start with an older model, since students are then in a position to scrutinize model assumptions and predictions in light of information that has surfaced only after publication of the paper. Understanding the epidemiology of AIDS is still of interest to our students; the systems of ODEs used to model the spread of the disease are fairly straightforward extensions of the basic SIR model, and are easily accessible to a student with some introductory ODEs exposure. We will present an outline of the classroom lectures and guided discussions, sample project assignments, and the research literature upon which the project is based. (Received September 07, 2013)

1095-34-267 **Dashiell Fryer*** (dashiell.fryer@pomona.edu), 640 North College Ave, Claremont, CA 91711. *Constructing Jordan Normal Forms.* Preliminary report.

I will discuss the merits of explicitly constructing Jordan normal forms in undergraduate differential equations classes requiring linear algebra. This will be accomplished in the context of the matrix exponential. In particular, I will show my method for constructing Jordan forms, the simplicity of linear stability theory once they have been attained, and discuss the assumptions that must be made for the construction to be well defined. (Received September 10, 2013)

1095-34-280 **Matthias Kawski*** (kawski@asu.edu), School of Mathematical &Statictical Sciences, Tempe, AZ 85044. *Control and interactive visualization in DE courses.* Preliminary report.

We argue that with the advent of ubiquitous modern computing technology we need to ask new, more engaging questions that, both, present meaningful problems, and allow to better assess whether learning outcomes have been met. At many levels, natural candidates are inverse problems. In differential equations courses, standard questions from control theory are immediate candidates. E.g., instead of predicting how a system will behave in the future, which is comparatively trivial with technology, we ask, how can we make the system behave in a desired way. We present new model examples for this approach, and support this with innovative uses of modern computing technology for interactive visualization. An important aspect of this program is the prospect of better engaging groups of students who traditionally have been underrepresented in such technical courses. (Received September 11, 2013)

35 ► Partial differential equations

1095-35-7 **Alejandro Velez-Santiago*** (alejandro.velez2@upr.edu). *Quasi-linear variable exponent parabolic problems with Wentzell-Robin boundary conditions on non-smooth domains.*

Let $p \in C^{0,1}(\overline{\Omega})$ be such that $1 < p_* := \operatorname{ess\,inf}_{\overline{\Omega}} p(x) \leq p^* := \operatorname{ess\,sup}_{\overline{\Omega}} p(x) < \infty$, let $\Omega \subseteq \mathbb{R}^N$ be a bounded $W^{1,p(\cdot)}$-extension domain, and let μ be an upper d-Ahlfors measure supported on $\partial\Omega$ with $d \in (N - p_*, N)$. We investigate the solvability of a class of quasi-linear boundary value problems involving the $p(\cdot)$-Laplace operator $\Delta_{p(\cdot)}$, and Wentzell-Robin boundary conditions. We establish that the realization of the $p(\cdot)$-Laplace operator with the above boundary conditions generates a (nonlinear) order-preserving submarkovian C_0-semigroup on $L^2(\Omega, dx) \times L^2(\partial\Omega, d\mu)$, and hence, its associated first order Cauchy problems is well-posed on $L^{q(\cdot)}(\Omega, dx) \times L^{q(\cdot)}(\partial\Omega, d\mu)$ for all measurable function q with $1 \leq q_* \leq q^* < \infty$. In addition, a (nonlinear) ultracontractivity property for such semigroup is achieved, which implies as a consequence that mild solutions of the above boundary value problem are globally bounded. (Received April 20, 2013)

1095-35-15 **Thinh Tri Kieu*** (thinh.kieu@ttu.edu), 4306 16th Street Quaker Pines Apt#5, Lubbock, TX 794126, **Luan Hoang** (luan.hoang@ttu.edu), Department of Mathematics and Statistics, Box 41042 Lubbock, TX 79409–1042, U.S.A, Lubbock, TX 79409, **Akif Ibraguimov** (akif.ibraguimov@ttu.edu), Department of Mathematics and Statistics, Box 41042 Lubbock, TX 79409–1042, U.S.A, Lubbock, TX 79409, and **Zeev Sobol** (z.sobol@swansea.ac.uk), Department of Mathematics, Swansea University, Singleton Park, Swansea, SA2 8PP, Wales, U.K, Singleton Park, SA2 8PP, United Kingdom. *Stability of solution to generalized Forchheimer equations of any degree.*

The non-linear Forchheimer equations are considered as laws of hydrodynamics in porous media in case of high Reynolds numbers, when the fluid flows deviate from the ubiquitous Darcy's law. In this article, the dynamics of generalized Forchheimer equations for slightly compressible fluids are studied by means of the resulting initial boundary value problem for the pressure.

We prove that the solutions depend continuously on the boundary data and the Forchheimer polynomials both in finite time and at time infinity.

In contrast to related long-time dynamics results which are in the L^2-context and require a restriction on the degree of the Forchheimer polynomial, the results obtained here are for general L^α-spaces and without this degree restriction.

New bounds for the solutions are established in L^α-norm for all $\alpha \geq 1$, and then are used to improve estimates for their spatial and time derivatives.

New Poincaré-Sobolev inequalities and non-linear Gronwall-type estimates for non-linear differential inequalities are utilized to achieve better asymptotic bounds. The methods developed are general and can be applied to other degenerate parabolic equations of similar structure. (Received June 10, 2013)

1095-35-19 **Kazuo Yamazaki*** (kyamazaki@math.okstate.edu), 401 Mathematical Sciences Building, Department of Mathematics, Oklahoma State University, Stillwater, OK 74078. *Recent developments on the generalized magnetohydrodynamical systems with fractional Laplacian.*

We discuss recent developments on the global regularity issue of the generalized magnetohydrodynamical system with fractional Laplacians. In the case dimension is three, we discuss its Serrin-type regularity criteria improvements in terms of component reduction. In the case dimension is two, we discuss how the powers of the fractional Laplacians on the dissipative and diffusive terms affect the global regularity issues of the solution pair. (Received July 10, 2013)

1095-35-26 **Viktor Grigoryan*** (vgrigoryan@oxy.edu), Department of Mathematics, Occidental College, 1600 Campus Road, Los Angeles, CA 90041. *Improved local well-posedness for quadratic derivative non-linear wave equations in two dimensions.*

The regularity threshold for the local well-posedness for the quadratic derivative non-linear wave equation in two dimensions is know to be above the scaling regularity for data in regular Sobolev spaces. We consider data in the Fourier-Lebesgue spaces, $\widehat{H}^r_s$, which coincide with the Sobolev spaces of the same regularity for $r = 2$, but scale like lower regularity Sobolev spaces for $1 < r < 2$. Using careful Fourier analysis, we obtain local well-posedness in the Fourier-Lebesgue spaces for a range of exponents s and r, which improves on the best know Sobolev result. When the nonlinearity has a null-form structure, we achieve almost critical well-posedness, by using the transfer principle for our solution spaces and establishing the necessary estimates on free waves. The last result can be extended to other models containing null-forms, which we demonstrate on the example of the Ward wave map problem. This is joint work with A. Tanguay (general qudratic nonlinearities) and A. Nahmod (null-form nonlinearities). (Received August 07, 2013)

1095-35-36 **Alexander V Turbiner*** (turbiner@nucleares.unam.mx), Ciudad Universitaria, Apartado Postal 70-543, 04510 Mexico City, DF, Mexico. *BC_1 Lame equation.* Preliminary report.

BC_1 Lame (generalized Lame) equation is introduced in the form of the Schroedinger equation with potential given by superposition of two Weierstrass functions. Coupling constants for which polynomial solutions exist as well as the hidden algebraic structure are found. (Received August 21, 2013)

1095-35-39 **Alejandro Vélez-Santiago*** (alejandro.velez-santiago@ucr.edu). *Ambrosetti–Prodi-type problems for quasi-linear elliptic equations with nonlocal boundary conditions.*

Let $\Omega \subseteq \mathbb{R}^N$ be a bounded Lipschitz domain, for $N \geq 2$, and let $2N(N+2)^{-1} < p < \infty$. We investigate the solvability of the Ambrosetti–Prodi problem with nonlocal boundary conditions, formally defined by

$$\begin{cases} -\Delta_p u = f(x,u) + \xi \ \text{ in } \Omega, \\ |\nabla u|^{p-2}\dfrac{\partial u}{\partial \nu} + \Theta_p u = 0 \ \text{ on } \partial\Omega\,, \end{cases}$$

for $f : \Omega \times \mathbb{R} \to \mathbb{R}$ a Carathéodory function satisfying a sort of eigenvalue crossing, and $\xi \in \mathbb{R}$ a parameter, where Δ_p denotes the p-Laplace operator, and Θ_p denotes a nonlocal Besov operator. Using a priori estimates, regularity theory, a sub-supersolution method, and the Leray-Shauder degre theory, we obtain a necessary condition for the non-existence of solutions (in the weak sense), the existence of at least one minimal solution, and the existence of at least two distinct solutions. Moreover, when the boundary value problem is solvable, we prove that the weak solutions are Hölder continuous over $\overline{\Omega}$. (Received August 22, 2013)

1095-35-50 **Kalea Sebesta*** (k_sebesta@yahoo.com), 200 Talus Way, Apt 212, Reno, NV 89503.
Nucleation in a Two Component Metal Alloy. Preliminary report.

This is a numerical study that explores the phase separation phenomenon, known as nucleation, specifically in a two component metal alloy. The aim of this study is to understand the change in the number of components both as a function of time and a function of parameters. In order to accomplish this, numerical topology code to find the number of components was developed and analysis was used to develop some heuristic arguments. For the purpose of this research, a stochastic equation was used implying, that there are necessarily large deviations in behavior in an individual run. Therefore, it was necessary to perform and average a large number of simulations to see the full scope of the behavior. These arguments paved way for predictions of the expected behavior both in time and in parameter variation. Furthermore, the stochastic behavior is what gave rise to the predictions for how the behavior should change in time. The results are based on the theory of large deviations which say that the time to nucleation should depend on the largest eigenvalue.
(Received August 23, 2013)

1095-35-52 **Kurt E Anderson** and **Jonathan J Sarhad*** (jonathan.sarhad@ucr.edu).
Spatial perturbations and response of a single population dispersing via diffusion–advection in a bounded domain (preliminary report). Preliminary report.

A reaction–diffusion–advection equation (in one spatial dimension) approximates the behavior of a single species which obeys a logistic growth law and disperses in space via a diffusion–advection process. This model is applied to both unbounded and bounded habitats; in the latter case, a large class of boundary conditions are considered. Spatial heterogeneity is introduced to the steady-state via small sinusoidal perturbations to system parameters such as carrying capacity, diffusion, and advection. In unbounded domains, the Fourier Transform (in space) facilitates analysis by providing simple relationships between perturbation (*input*) and population response (*output*), via the use of a well–known complex–valued *transfer function*. In the bounded domain, spatial Fourier Transform methods are not useful. However, the results for the unbounded domain can be useful as a baseline for comparison to numerical results for the bounded domain. Preliminary results include convergence of the bounded domain results to the unbounded domain results in certain limits of domain size and perturbation frequency. (Received August 23, 2013)

1095-35-60 **Mihaela Ignatova*** (mihaelai@stanford.edu), **Igor Kukavica**, **Irena Lasiecka** and **Amjad Tuffaha**.
On the well-posedness of a free boundary fluid-structure model.

We address the well-posedness of a fluid-structure interaction model describing the motion of an elastic body immersed in an incompressible fluid. The fluid-structure system consists of the incompressible Navier-Stokes equations and a damped linear wave equation coupled through transmission boundary conditions on the free moving interface separating the elastic body and the fluid. We provide a priori estimates for the local-in-time existence of solutions for a class of initial data which also guarantees uniqueness. In the second part of the talk, we address the global-in-time existence and exponential decay of solutions to the system for given sufficiently small initial data. (Received August 26, 2013)

1095-35-66 **Mariana Smit Vega Garcia*** (msmitveg@math.purdue.edu), msmitveg@math.purdue.edu, and **Nicola Garofalo**.
Optimal regularity in the Signorini problem with variable coefficients and new monotonicity formulas.

We will start by describing the interior Signorini, or lower-dimensional obstacle problem, for a uniformly elliptic divergence form operator $L = \operatorname{div}(A(x)\nabla)$ with Lipschitz continuous coefficients and discuss the optimal regularity of the solution. Our main result states that, similarly to what happens when $L = \Delta$, the variational solution has the optimal interior regularity $C^{1,\frac{1}{2}}_{loc}(\Omega_{\pm} \cup \mathcal{M})$, where $\mathcal{M}$ is a codimension one flat manifold which supports the obstacle and divides the domain Ω into two parts, Ω_+ and Ω_-. We achieve this by proving some

new monotonicity formulas for an appropriate generalization of the celebrated Almgren's frequency functional. (Received August 27, 2013)

1095-35-73 **Ratnasingham Shivaji*** (shivaji@uncg.edu), Dept of Mathematics & Statistics, UNCG, Greensboro, NC 27402. .

We consider the problem

$$\begin{aligned} -\Delta_p u &= \frac{a u^{p-1} - b u^{\gamma-1} - c}{u^{\alpha}}, \quad && x \in \Omega \\ u &= 0, && x \in \partial\Omega \end{aligned}$$

where $\Delta_p u = \operatorname{div}\left(|\nabla u|^{p-2}\nabla u\right)$, $p > 1$, Ω is a smooth bounded domain in $\mathbb{R}^n$, $a > 0$, $b > 0$, $c \geq 0$, $\gamma > p$ and $\alpha \in (0, 1)$. Given a, b, γ, and α, we establish the existence of a positive solution for small values of c. (Received August 28, 2013)

1095-35-80 **Igor Kukavica** (kukavica@usc.edu), KAP 262C, 3620 S Vermont Ave, Los Angeles, CA 90089, **Yuan Pei*** (ypei@usc.edu), 2636 Menlo Ave, Los Angeles, CA 90007, **Walter Rusin** (wrusin@usc.edu), KAP 416B, 3620 S Vermont Ave, Los Angeles, CA 90089, and **Mohammed Ziane** (ziane@math.usc.edu), KAP 444A, 3620 S Vermont Ave, Los Angeles, CA 90089. *Primitive Equations with Continuous Initial Data.*

We address the well-posedness of the primitive equations of the ocean with only continuous initial data that requires no differentiability. We show that the splitting of the initial data into a regular finite energy part and a small bounded part is preserved by the equations thus leading to existence and uniqueness of solutions. We deal with the main difficulty that comes from the pressure term and the derivative loss term. Moreover, we point out that in order to obtain uniqueness, we only require one of the two bounded parts of the two solutions to be small. (Received August 28, 2013)

1095-35-111 **Chuntian Wang*** (wang211@umail.iu.edu), Rawles Hall, 831 East 3rd St, Bloomington,, IN 47408. *Intial and boundary value problems of the Zakharov-Kuznetsov Equation in a bounded domain.*

The Zakharov-Kuznetsov (ZK) equation, a model arising from plasma physics, is a 2 or $3D$ wave equation of the family of the Korteweg-de Vries (KdV) equations. Recently the ZK equation has attracted considerable attention not only because it is closely related with the physical phenomena but also because it contributes to the understanding of more general problems that are partly hyperbolic (such as the inviscid primitive equations).

In this talk, we present some recent mathematical results concerning the ZK equation in a bounded domain motivated by the study of boundary control problems. New difficulties arise, in particular, the linear operator associated with this model is neither symmetric nor coercive and has an anisotropic structure. To overcome these difficulties, we have applied novel energy estimates. Moreover, new technical tools combining the distribution theories and the Fourier expansions have been developed to deal with the boundary conditions. Furthermore the proof of uniqueness of weak solutions provides an idea of how to deal with the lack of regularity of the difference of the solutions.

These are the joint works with R. Temam, N. Glatt-Holtz and J-C. Saut. (Received September 03, 2013)

1095-35-145 **Chanwoo Kim*** (ckim.pde@gmail.com), Cambridge, United Kingdom, **Yan Guo**, Providence, RI, **Daniela Tonon**, Paris, France, and **Ariane Trescases**, Cachan, France. *Regularity of the Boltzmann equation in convex domains.*

We consider the Boltzmann equation in convex domains with various boundary conditions. We establish weighted C^1 estimates. We also discuss the non-existence of second order derivatives. (Received September 07, 2013)

1095-35-171 **Georg Hetzer*** (hetzege@auburn.edu), Department of Mathematics and Statistics, 304 Parker Hall, Auburn University, Auburn, AL 36849-5310. *Functional Reaction-Diffusion Problems from Climate Modeling.*

Motivated by coupling an energy balance climate model and a competition model with local or nonlocal dispersal for the bio-sphere, one is led to study functional reaction-diffusion equations on the 2-sphere with slow diffusion, memory, and a term involving a nonlocal Volterra type operator. The talk will summarize recent results on existence and long-term behavior (trajectory attractor). (Received September 08, 2013)

1095-35-181 **David G Costa*** (costa@unlv.nevada.edu), Dept of Mathematical Sciences, 4505 Maryland Parkway, Bos 454020, Las Vegas, NV 89154-4020. *Critical nonlinearities and nonlinear Schrödinger equations.*

We study compactness properties of critical Sobolev embeddings with applications to nonlinear singular Schrödinger equations. Although the situations in dimensions $N > 2$ and $N = 2$ are quite different in many ways (critical

rates of growth, energy spaces and corresponding embeddings into Lebesgue-type spaces), we present a *unified approach* where the differences between dimensions $N > 2$ and $N = 2$ can be understood as a realization of common phenomena. This is joint work with J.M. do Ó and K. Tintarev. (Received September 08, 2013)

1095-35-191 **Stephen Robinson*** (sbr@wfu.edu), NC , and **Pavel Drabek**. *Resonance problems with respect to the Fucik Spectrum.*

We consider the boundary value problem

$$-\Delta u = \alpha u^+ - \beta u^- + g(u) + h \text{ in } \Omega, u = 0 \text{ on } \partial\Omega,$$

where Δ is the Laplace operator, (α, β) is in the Fucik Spectrum, $g : R \to R$ is bounded and continuous, and Ω is a bounded domain in R^n. We prove an existence theorem subject to a Landesman-Lazer type condition on the primitive of g. The proof relies on a variational characterization of the Fucik Spectrum due to Castro and Chang. (Received September 09, 2013)

1095-35-204 **Eun Heui Kim***, Department of Mathematics and Statistics, California State University Long Beach, Long Beach, CA 90840. *Global solutions for transonic self-similar two-dimensional Riemann problems.*

We discuss the recent development of multi-dimensional transonic Riemann problems. More precisely we discuss analytical results and numerical results on a simplified model system – the nonlinear wave system. (Received September 09, 2013)

1095-35-211 **Nghiem V. Nguyen*** (nghiem.nguyen@usu.edu), Department of Mathematics and Statistics, Utah State University, 3900 Old Main Hill, Logan, UT 84322-3900. *Existence and stability of a two-parameter family of solitary waves for a 2-coupled nonlinear Schrodinger system.*

In this talk, the existence and stability results for a two-parameter family of vector solitary-wave solutions (*i.e* both components are nonzero) of the nonlinear Schrödinger system

$$\begin{cases} iu_t + u_{xx} + (a|u|^2 + b|v|^2)u = 0, \\ iv_t + v_{xx} + (b|u|^2 + c|v|^2)v = 0, \end{cases}$$

where u, v are complex-valued functions of $(x, t) \in \mathbb{R}^2$, and $a, b, c \in \mathbb{R}$ are established. The results extend our earlier ones as well as those of Ohta, Cipolatti and Zumpichiatti and de Figueiredo and Lopes. As opposed to other methods used before to establish existence and stability where the two constraints of the minimization problems are related to each other, our approach here characterizes solitary-wave solutions as minimizers of an energy functional subject to two independent constraints. The set of minimizers is shown to be stable; and depending on the interplay between the parameters a, b and c, further information about the structures of this set are given. (Received September 09, 2013)

1095-35-226 **Susan Friedlander** and **Walter Rusin*** (walter.rusin@okstate.edu). *Active Scalar Equations and the second iterate.*

We consider an iterative resolution scheme for a broad class of active scalar equations with a fractional power γ of the Laplacian and focus our attention on the second iterate. The main objective of our work is to analyze boundedness properties of the resulting bilinear operator. Our results are two-fold: we prove continuity of the bilinear operator in $\dot{B}^0_{1,\infty}$- in the critical regime $\gamma = 1/2$; for equations with an even symbol we show that the $B^{-\gamma}_{q,\infty}$-regularity, where $q > 2$, is in a sense a minimal necessary requirement on the solution. (Received September 09, 2013)

1095-35-227 **Djairo G. de Figueiredo*** (djairo@ime.unicamp.br), Dept. Math IMECC, UNICAMP, Campinas, SP , Brazil. *Nonhomogeneous Dirichlet Problems for the p–Laplacian.*

We study the existence, nonexistence and multiplicity of positive solutions for a family of problems $-\Delta_p u = f_\lambda(x, u)$ in Ω, $u = \varphi$ on $\partial\Omega$, where $\lambda > 0$ is a parameter. The family we consider includes the the Pohozaev type equation $-\Delta_p u = \lambda u^{p^*-1}$. The main feature is the consideration of the p–Laplacian $-\Delta_p$ together with a nonzero boundary condition φ. We prove an extension of the Brezis-Nirenberg result on local minimization in $W^{1,p}$ and C^1, also a $C^{1,\alpha}$ estimate for a family of equations with critical growth, and a variational approach to the method of upper-lower solutions. (Received September 09, 2013)

1095-35-252 **Joon Hyuk Kang*** (kang@andrews.edu), Mathematics Department, 4260 Administration Dr., Berrien Springs, MI 49104. *Two species of animals residing in the same environment.*

Two species of animals are competing in the same environment. Under what conditions do they coexist peacefully? Or under what conditions is either one of the two species become extinct, that is, either one of the two

species excluded by the other? It is natural to say that they can coexist peacefully if their reproduction rates and self-limitation rates are relatively larger than those of competition rates. In other words, they can survive if they interacts strongly among themselves and weakly with others. We investigate this phenomena in the mathematical point of view by modeling of a system of Partial Differential Equations. (Received September 10, 2013)

1095-35-275 **Igor Kukavica*** (kukavica@usc.edu) and **Amjad Tuffaha**. *A regularity result for the incompressible Euler equation with a free interface.*

We address the local existence of solutions of the 2D and 3D water wave problems. For the space dimension three, we consider the irrotational datum and prove that the local in time existence holds for initial velocities belonging to $H^{2.5+\delta}$, where $\delta > 0$ is arbitrary. For the space dimension two, the data does not need to be irrotational. We prove the local in time existence when the initial velocity belongs to $H^{2+\delta}$ and the initial vorticity is in $H^{1.5+\delta}$, where $\delta > 0$ is arbitrary. (Received September 10, 2013)

1095-35-277 **Ning Ju*** (ning.ju@okstate.edu), 401 Mathematical Sciences, Oklahoma State University, Stillwater, OK. *The Primitive Equations for viscous incompressible flows.*

The system of Primitive Equations (PEs) for viscous incompressible fluid is one of the most fundamental mathematical models for large scale dynamics of ocean and atmosphere in Geophysical Fluid Dynamics.

J.L. Lions, R. Temam and S. Wang formulated the mathematical framework and proved existence of global weak solutions. Existence of strong solutions local in time and their uniqueness were later obtained by several researchers. Existence of strong solutions global in time was recently proved independently by C. Cao and E. Titi, by G. Kobelkov and by Kukavica and Ziane. Existence of the global attractor for long time dynamics was proved by N. Ju.

In this talk, new results of the speaker on PEs will be reported and discussed. Some of them were recently obtained jointly with Professor R. Temam. (Received September 10, 2013)

37 ► Dynamical systems and ergodic theory

1095-37-11 **Anton Gorodetski*** (asgor@math.uci.edu), Department of Mathematics, Irvine, CA 92697. *Dynamics of the Trace Map and spectral properties of the Fibonacci Hamiltonian.*

We describe numerous dynamical properties of the Trace Map $(x, y, z) \mapsto (2xy - z, x, y)$. As an application, detailed description of spectral properties of the Fibonacci Hamiltonian (as well as Square and Cubic Fibonacci Hamiltonian) is provided. This talk is a summary of different results joint with D.Damanik, B.Solomyak, and W.Yessen. (Received May 11, 2013)

1095-37-23 **J. Ding*** (jiudin@gmail.com), Department of Mathematics, University of Southern Mississippi, 118 College Dr., Box 5045, Hattiesburg, MS 39406, and **N. Rhee**. *A Stable Maximum Entropy Method with High Precision for Invariant Density Computation.*

The traditional maximum entropy method has a serious ill-conditioning issue. We have succeeded in simplifying the nonlinear equations, the solution of which is the main numerical work of the method, so that the condition number of the system is very small. And thus we have developed a fast and stable piecewise polynomial maximum entropy method for the computation of invariant densities of deterministic dynamical systems. (Received August 02, 2013)

1095-37-28 **Stefan Müller***, University of Illinois at Urbana-Champaign, Department of Mathematics, 1409 W Green Street, Urbana, IL 61801. *Topological Hamiltonian and contact dynamics.*

In classical mechanics the dynamics of a Hamiltonian vector field model the motion of a particle in classical phase space, and the dynamics of a contact vector field play a similar role in geometric optics (in the mathematical model of Huygens' principle). Topological Hamiltonian dynamics and topological contact dynamics are recent theories that explore natural questions regarding the regularity of such dynamical systems. In a nutshell, they admit genuine generalizations to non-smooth dynamical systems with non-smooth generating (contact) Hamiltonian functions.

The talk begins with examples that illustrate the central ideas and lead naturally to the key definitions. The main technical ingredient is the well-known energy-capacity inequality for displaceable subsets of a symplectic manifold. We use it to prove an extension of the classical 1-1 correspondence between isotopies and their generating Hamiltonians. This crucial result turns out to be equivalent to certain rigidity phenomena for smooth Hamiltonian and contact dynamical systems. The rest of the talk addresses sample applications to topological

dynamics and to Riemannian geometry. In particular, we prove a rigidity result for the geodesic flows associated to a uniformly weakly convergent sequence of Riemannian metrics. (Received August 13, 2013)

1095-37-84 **Filiz Tumel*** (ftumel@northamerican.edu), North American University, 3203 N Sam Houston Pkwy W, Houston, TX 77038. *Statistical Properties of Extended Systems with Random Jumps.*

In this talk, we discuss statistical properties of dynamical systems on a lattice with randomly occurring jumps. We use Perturbation Theory to derive the drift rate and the averaged Central Limit Theorem where the jumps happen on a union of countably many intervals. We obtain an upper bound for the speed of convergence in the Central Limit Theorem and prove that the convergence is with tight maxima. We prove Large Deviation results and the quenched Central Limit Theorem. Finally, we expand the drift rate results and the averaged Central Limit Theorem to certain non-uniformly expanding systems. (Received August 30, 2013)

1095-37-86 **Brian C Ryals*** (ryals@usc.edu). *Synchronization and Phase-locking in a family of Coupled Oscillators.* Preliminary report.

A three-parameter family of discrete time models of N coupled oscillators will be discussed, so that the phase space is the N-torus. Synchronized and phase-locked states correspond to invariant circles on the torus, and can be viewed as fixed points in a quotient dynamical system. Results will focus on these fixed points and be a mix of rigorous and numerical results. (Received August 30, 2013)

1095-37-87 **Kening Lu*** (klu@math.byu.edu) and **Wen Huang**. *Entropy, chaos and weak Horseshoe for infinite dimensional Random dynamical systems.*

In this talk, we present an answer to the problem on the implication of positive entropy of a random dynamical system. We study continuous infinite dimensional random dynamical systems in a Polish space, do not assume any hyperbolicity, and prove that chaos and weak horseshoe exist inside the random invariant set when its entropy is positive. This result is new even for finite dimensional random dynamical systems and infinite dimensional deterministic dynamical systems generated by either parabolic PDEs or hyperbolic PDEs. We mention that in general one does not expect to have a horseshoe without assuming hyperbolicity. For example, consider the product system of a circle diffeomorphism with an irrational rotation number and a system with positive entropy. This product system has positive entropy and a weak horseshoe, but has no horseshoe. This is a joint work with Wen Huang. (Received August 31, 2013)

1095-37-103 **Eugen Andrei Ghenciu*** (ghenciue@uwstout.edu) and **Mario Roy** (mroy@glendon.yorku.ca). *Bowen Formula in Generalized Iterated Constructions.* Preliminary report.

A generalized iterated construction is the most general setting in which one can construct a limit sets extending the ideas from Graph Directed Markov Systems introduced by Mauldin and Urbanski. We prove that if there are finitely many iterates, the Bowen formula holds; meaning the Hausdorff dimension of the limit set is the zero of the associated topological pressure. Several examples and applications will be shown. (Received September 03, 2013)

1095-37-108 **Todd Fisher*** (tfisher@math.byu.edu) and **Jerome Buzzi**. *Entropy variation for smooth systems.*

Topological entropy is locally constant among uniformly hyperbolic diffeomorphisms and certain partially hyperbolic maps. It is also constant on neighborhood of some diffeomorphisms that are not partially hyperbolic, but are isotopic to an Anosov map. We show that this phenomenon is not universal: there exists an open set of diffeomorphisms where the topological entropy is nowhere locally constant. (Received September 03, 2013)

1095-37-109 **Chinmaya Gupta*** (chinmaya@math.uh.edu), Department of Mathematics, University of Houston, Houston, TX 77204, and **William Ott** and **Andrei Torok**. *Memory loss for time-dependent piecewise expanding systems.*

We will show that given two probability measures absolutely continuous with respect to a reference measure, the quasi-Hölder distance between them (and therefore, the L^1 distance between them) decreases exponentially under action by compositions of arbitrarily chosen (but fixed *a priori*) maps close to those that are both piecewise expanding and mixing in a certain sense. Thus, we will establish a counterpart of exponential decay of correlations for non-stationary systems. (Received September 03, 2013)

1095-37-119 **Romain Aimino**, **Matthew Nicol*** (nicol@math.uh.edu) and **Sandro Vaienti**.
Annealed and quenched limit theorems for random expanding systems.

Suppose we choose maps $\{T_i\}$ independently according to a probability measure μ on S. The maps $T_i : X \to X$ act on a metric space X which supports a probability measure m. This gives rise to a random dynamical system which may be modeled in a standard way as a skew-product. Annealed dynamics refers to the skew-product dynamics defined on the product space $X \times S^Z$ according to the product measure $m \times \mu^Z$. Quenched dynamics consists in fixing $\omega \in \Omega$ and looking at the behavior of the resulting fixed composition of maps. We give conditions under which an annealed transfer operator has a spectral gap on a suitable Banach space and using this to establish annealed and quenched versions of central limit theorems, large deviations results and other statistical properties. Applications include settings where the chosen maps may include non-uniformly expanding and intermittent type maps. (Received September 04, 2013)

1095-37-121 **Anushaya Mohapatra*** (mohapatr@math.uh.edu) and **William Ott**. *Rank one dynamics near heteroclinic cycles.*

Identifying mechanisms that produce nonuniform hyperbolicity and proving that nonuniform hyperbolicity is present in concrete models remain major challenges. We discuss the emergence of nonuniformly hyperbolic dynamics when certain flows with heteroclinic cycles are subjected to time-periodic forcing. In particular, we show the emergence of SRB measures and rank one chaos that is both sustained in time and physically observable. Heteroclinic cycles have been studied extensively in connection with dynamics on networks and systems possessing symmetries. Our results are independent of symmetry considerations: they apply in the presence of symmetries and in the absence of symmetries. (Received September 07, 2013)

1095-37-123 **Christoph Marx***, Mathematics 253-37, Caltech, Pasadena, CA 91125, and **Svetlana Jitomirskaya** (szhitomi@math.uci.edu), 340 Rowland Hall, University of California, Irvine, Irvine, CA 92697-3875. *Absence of point spectrum for the self-dual Extended Harper's Model.*

Absence of point spectrum for the self-dual Extended Harper's Model

An interesting feature of extended Harper's model (EHM), a generalization of the almost Mathieu operator popularized by DJ Thouless, is the appearance of a large regime of coupling parameters invariant under Aubry duality ("self-dual regime"). In this regime, extensive numerical analysis in physics literature conjecture a "strange collapse" from purely singularly continuous to purely absolutely continuous spectrum, determined by the symmetries of the model.

Based on earlier work on EHM [2], we have recently proven this conjecture [1] by excluding eigenvalues in the self-dual regime for a full measure set of phases and frequencies. The work is joint with S. Jitomirskaya.

[1] S. Jitomirskaya, C. A. Marx, On the spectral theory of Extended Harper's Model, preprint (2013).

[2] S. Jitomirskaya, C. A. Marx, Analytic quasi-periodic cocycles with singularities and the Lyapunov Exponent of Extended Harper's Model, Commun. Math. Phys. 316, 237-267 (2012). (Received September 05, 2013)

1095-37-139 **Stephen Muir*** (muirst@ucr.edu). *Thermodynamic formalism for a modified shift.*

I will review recent joint research with Mariusz Urbanski studying the fundamental objects and theorems of thermodynamic formalism in a novel "modified" shift space. Then I will indicate how this modified shift serves as a prototype for the general concept of "pseudoexpanding" dynamics, which is currently being developed. Finally I will discuss some concrete examples in which the pseudoexpanding thermodynamic formalism may provide new results. (Received September 06, 2013)

1095-37-154 **Mauricio A. Rivas*** (el_mauri_cio_alex@yahoo.com), University of Houston, Department of Mathematics, Houston, TX 77204-3008, and **William Ott**. *Observing Differentiable Dynamical Systems on Infinite-Dimensional Hilbert Spaces.*

We study the extent to which inferences about differentiable infinite-dimensional dynamical systems follow from examining observations of such systems. Let H be a separable infinite-dimensional real Hilbert space, $f : HightarrowH$ a map and A a compact subset of H such that $f(A) = A$. We prove that for almost every (in the sense of prevalence) continuously differentiable observation map $phi : HightarrowmathbbM^m$, the existence of a quasi-differentiable map $ildef : phi(A)ightarrowphi(A)$ implies that phi is an injective immersion on A. (Received September 08, 2013)

1095-37-173 **Chinmaya Gupta** (ccgupta@math.uh.edu) and **Nicolai T A Haydn*** (nhaydn@usc.edu), Los Angeles, CA 90089, and **Milton Ko** (miltonko@gmail.com) and **Erika A Rada-Mora** (alejarada@gmail.com). *The growth rate of entrance times in dynamical systems.*

For ergodic systems with generating partitions, the well known result of Ornstein and Weiss shows that the exponential growth rate of the recurrence time is almost surely equal to the metric entropy. Here we look at the exponential growth rate of entrance times, and show that it equals the entropy, where the convergence is in probability in the product measure. This is however under the assumptions that the limiting entrance times distribution exists almost surely. This condition looks natural in the light of an example by Shields in which the limsup in the exponential growth rate is infinite almost everywhere but where the limiting entrance times do not exist. We then also consider ϕ-mixing systems and prove a result connecting the Rényi entropy to sums over the entrance times orbit segments. (Received September 08, 2013)

1095-37-209 **Andrew Torok*** (torok@math.uh.edu) and **Viorel Nitica**. *Stable transitivity for Heisenberg group extensions of hyperbolic systems.*

Consider skew-extensions with fiber the standard real Heisenberg group $\mathcal{H}_n$ of a uniformly hyperbolic dynamical system. We show that among the C^r extensions ($r > 0$) that avoid an obvious obstruction, those that are topologically transitive contain an open and dense set. More precisely, we show that an $\mathcal{H}_n$-extension is transitive if and only if the $\mathbb{R}^{2n}$-extension given by the abelianization of $\mathcal{H}_n$ is transitive.

In order to obtain this we prove a Diophantine approximation result for simultaneous solutions of a quadratic form and several linear forms. (Received September 09, 2013)

1095-37-219 **Nathaniel D Emerson*** (nemerson@usc.edu), USC Department of Math, 3620 South Vermont Avenue, KAP 406, Los Angeles, CA 90089-2532. *Automorphisms of Cubic Polynomials Outside the Shift Locus.* Preliminary report.

The cubic shift locus, $\mathcal{S}_3$, consists all cubic polynomials where both critical points tend to infinity under iteration. A cubic polynomial is topologically conjugate to the one-sided shift on 3 symbols if and only if it is in the shift locus. Thus any automorphism of the polynomial that is compatible with the dynamics, induces an automorphism of the 3-shift. The automorphism group of the 3-shift, denoted Aut_3, has a surprisingly rich algebraic structure. Blanchard, Devaney and Keen showed that there is a surjective homomorphism from $\pi_1(\mathcal{S}_3)$ to Aut_3.

We consider the *mixed* cubic polynomials, $\mathcal{E}_3^1$, which have one critical point with bounded orbit and one critical point that tends to infinity under iteration. Mixed polynomials are only semi-conjugate to the 3-shift. We present some preliminary results generalizing their results to these polynomials. In particular, we show that there is a surjective homomorphism from $\pi_1(\mathcal{E}_3^1)$ to Aut_3. (Received September 09, 2013)

1095-37-222 **Slobodan N. Simić***, Department of Mathematics and Statistics, San José State University, San José, CA 95192. *Anosov, Carnot-Carathéodory and Reeb.* Preliminary report.

The stable and unstable bundles of a generic Anosov flow define a Carnot-Carathéodory (a.k.a. subriemannian) geometry on the underlying manifold. This geometry plays an important role in understanding the dynamics of the Anosov system, the main difficulty being that unlike in the classical case, the horizontal distribution is usually not smooth. I will discuss some open questions in this setting and present some preliminary results. The talk will also explore connections between Anosov and Reeb vector fields from contact geometry. (Received September 09, 2013)

1095-37-224 **William Ott*** (ott@math.uh.edu), **Mark Tomforde** and **Paulette Willis**. *One-sided shift spaces over infinite alphabets.*

We define a notion of (one-sided) shift spaces over infinite alphabets. Unlike many previous approaches to shift spaces over countable alphabets, our shift spaces are compact Hausdorff spaces. We examine shift morphisms between these shift spaces, and identify three distinct classes that generalize the shifts of finite type. We show that when our shift spaces satisfy a property that we call "row-finite", shift morphisms on them may be identified with sliding block codes. As applications, we show that if two (possibly infinite) directed graphs have edge shifts that are conjugate, then the groupoids of the graphs are isomorphic, and the C^*-algebras of the graphs are isomorphic. (Received September 09, 2013)

1095-37-236 **Nicolai Haydn** (nhaydn@usc.edu), 3620 S. Vermont Ave., KAP 104, Los Angeles, CA 90089, and **Fan Yang*** (yang617@usc.edu), 3620 S. Vermont Ave., KAP 104, Los Angeles, CA 90089. *Entry and return times asymptotics for Bowen-balls.*

We review recent results on the hitting and recurrence rate of Bowen-balls for ergodic systems and compare them with known results on partitions. Then we will show relations between recurrence of Bowen- balls and that of regular geometric balls. (Received September 10, 2013)

1095-37-241 **Sabrina Kombrink*** (kombrink@math.uni-bremen.de). *Asymptotics of the tubular volume of self-conformal sets.*

The tubular volume of a set $A \subset \mathbb{R}^d$ is the function which maps a positive real number ϵ to the d-dimensional volume of the ϵ-parallel neighbourhood of A. Here, the ϵ-parallel neighbourhood of A is the set of all points whose Euclidean distance to A is less than or equal to ϵ. In the case that A is a non-empty compact convex set the well-known Steiner formula states that the tubular volume of A is a polynomial and the coefficients of this polynomial carry geometric information of the set A. For fractal sets the tubular volume is much more involved than for convex sets. We will focus on self-conformal sets, that is invariant sets of conformal iterated function systems, and discuss the leading asymptotic terms of the tubular volume for such sets and their geometric meaning. (Received September 10, 2013)

1095-37-242 **Marc Keßeböhmer** (mhk@math.uni-bremen.de), **Johannes Kautzsch** (kautzsch@uni-bremen.de), **Tony Samuel*** (tony@math.uni-bremen.de) and **Bernd O Stratmann** (bos@math.uni-bremen.de). *On the asymptotics of the transfer operators for α-Farey maps.*

The transfer operator $\widehat{T}$ is an important tool in the study of measure preserving dynamical systems (X, μ, T) where the measure μ has infinite mass. For instance, it allows one to obtain generalisations of Birkhoff's Ergodic Theorem. In these generalisations, one studies the asymptotics of the partial sums $\sum_{k=0}^{n} \widehat{T}^k$. However, it turns out that asymptotics of the operators $\widehat{T}^k$ themselves are considerably more delicate. In this talk we will discuss recent results concerning the asymptotic behaviour of the iterates of the transfer operators for α-Farey maps. (Received September 10, 2013)

1095-37-243 **May Mei*** (meim@denison.edu), Department of Mathematics, Denison University, P.O. Box 810, Granville, OH 43023-0810. *Fractal Spectra of Operators on Aperiodic Sequences and Tilings.*

The Nobel Prize-winning discovery of quasicrystals has spurred much work in aperiodic sequences and tilings. Here, we present numerical experiments conducted by undergraduates at the Summer Math Institute at Cornell under our supervision. Building on our previous work involving one-dimensional discrete Schrödinger operators with potentials given by primitive invertible substitutions on two letters, we present preliminary numerical data on the box-counting dimension and Hausdorff dimension of the spectrum of operators with potentials given by the Thue-Morse sequence and period doubling sequence. We also present preliminary numerical data on the spectrum of the discrete Laplacian on the Penrose tiling and octagonal tiling. (Received September 10, 2013)

1095-37-251 **Marek R Rychlik*** (rychlik@email.arizona.edu), University of Arizona, Department of Mathematics, Bldg 89, 617 N. Santa Rita Ave., Tucson, AZ 85721. *Modeling reliability of RAID systems.* Preliminary report.

RAID (Inexpensive Arrays of Inexpensive drives) are computer storage systems consisting of a large number of disk drives which are deemed not reliable. However, collectively the reliability and speed of the system increases. RAID systems use ECC (Error Correcting Codes) so that the loss of one or more drives does not result in data loss.

As the computer storage needs rapidly increase, RAID will consist of a large number of drives (hundreds and thousands). As an individual disk loses data every few days, it is important to understand the reliability of RAID through mathematical modeling. Early models in this area are Markov chains, assuming equal and constant rate of failure for the drives. These models allow us to predict MTTDL (Mean Time To Data Loss).

A realistic model, however, must take into accound repair schemes (replacement of broken drives, perhaps with a delay) and non-uniform failure rate of a drive with age (the inverted "bathtub curve"). In this talk, the resulting models will be discussed, which are systems of PDE, in which the number of equations is a random variable. Some systems will be rigorously analyzed, showing that the mathematics of these systems is both interesting and complex. (Received September 10, 2013)

1095-37-255 **John Antonioli*** (antoniol@uvic.ca). *Infinite-to-one factors of shifts of finite type and compensation functions.*

In recent years a number of "technological advancements" have led to a much more detailed picture of infinite-to-one factors of shifts of finite type. We will discuss some results relating to entropy and equilibrium states stemming from this work. In particular we will discuss a phase transition related to compensation functions for these factors. (Received September 10, 2013)

1095-37-261 **Rolando de Santiago*** (desantiagorolando@gmail.com), **Michel L Lapidus**, **Scott A Roby** and **John A Rock**. *Lattice strings and the Minkowski nonmeasurability of recursive strings.*

The structure of complex dimensions of lattices strings is a central topic in the study of self-similar fractal strings. In the special case of lattice strings, it will be shown that there is a connection between lattice strings and linear recurrence relations with regard to the multiplicities of lengths and the set of complex dimensions. We generalize this structure to the class of generalized fractal strings called recursive strings which have complex dimensions that exhibit a type of lattice structure. In this talk, we discuss the development of recursive strings and their complex dimensions as well as a criterion for Minkowski measurability in the context of ordinary fractal strings. In particular, this criterion reveals the fact that the boundary of an ordinary fractal string which is a recursive string is Minkowski nonmeasurable. (Received September 10, 2013)

1095-37-271 **Nishu Lal*** (lal@oxy.edu), Department of Mathematics, Occidental College, 1600 Campus Road, Los Angeles, CA 90041, and **Michel Lapidus** (lapidus@math.ucr.edu), Department of Mathematics, University of California, Riverside, Riverside, CA 92521. *The decimation method for Laplacians on fractals.*

We discuss the decimation method for several different self-similar fractals. Furthermore, we discuss the spectral zeta function of the Laplacian on these self-similar fractals, in particular the finite Sierpinski gasket and its blowup, known as the infinite Sierpinski gasket. The spectral zeta function of the Laplacian on the infinite Sierpinski gasket has a factorization formula expressed in terms of a suitable hyperfunction and the spectral zeta function associated with the finite Sierpinski gasket. (Received September 10, 2013)

42 ► Fourier analysis

1095-42-1 **Michael Christ*** (mchrist@berkeley.edu), Department of Mathematics, University of California, Berkeley, CA 94720. *Better Analysis through Additive Combinatorics: The Quest For Structure.*

Three fundamental inequalities in geometry and analysis are those of Brunn-Minkowski, Riesz-Sobolev, and Young. Each is invariant under the full group of affine symmetries of $\mathbb{R}^d$. Each is an exact equality only for sets with particular structure; these sets are continuum analogues of arithmetic progressions.

After reviewing these inequalities and their long histories, we will introduce recent results characterizing those sets that *nearly* achieve equality, and will reinterpret these conclusions as yet sharper inequalities. The results rely on an interplay between analysis, geometry of $\mathbb{R}^d$, and structural input from additive combinatorics. Two fundamental inverse theorems of additive combinatorics and an ancient inequality of Cauchy will be reviewed.

Hölder-Brascamp-Lieb (HBL) inequalities are a vast common generalization of all these inequalities. Recent progress with multiple collaborators includes a characterization of cases of equality in a new class of instances, calculation of optimal constants in discrete inequalities, discovery of a connection with Hilbert's Tenth Problem, and an application to communication minimizing algorithms in computer science. We will touch lightly on these developments. (Received September 04, 2013)

1095-42-59 **M. M. Rao*** (rao@math.ucr.edu), Riverside, CA 92502. *Harmonic Analysis of Some Second Order Stochastic Processes.*

Integral representations of second order stochastic processes including the weakly stationary, harmonizable and dissipative classes are given. These results make up of interesting applications of harmonic analysis in Hilbert space. (Received August 26, 2013)

1095-42-115 **Michael Christ*** (mchrist@berkeley.edu), Dept of Mathematics, Berkeley, CA 94720, and **Taryn Flock** (tflock@math.berkeley.edu), UC Berkeley, Berkeley, CA 94720. *On cases of equality in inequalities of Hardy-Riesz-Brascamp-Lieb-Luttinger type.*

In the 1930s Hardy, Riesz, and Sobolev discovered established primordial rearrangement inequalities, which give upper bounds for trilinear forms defined by convolution and integration. The foundational case is that of

indicator functions of subsets of the real line. These inequalities were generalized to forms of arbitrary degree by Brascamp-Lieb-Luttinger in 1974. Equality is attained when the sets are intervals centered at the origin.

Our work is concerned with the uniqueness question of characterizing all cases of equality. The first result of this type was obtained in 1996 by Burchard, who treated the basic trilinear case and a small family of extensions, in which the degree of the form is minimal. No other results of this type seem to have been known.

We characterize cases of equality for functions of one real variable, at the opposite end of the spectrum of possibilities, allowing forms of arbitrarily high degree but considering only those defined by integration over a two-dimensional space. The proof, like those of Riesz and Burchard, relies on a deformation method. (Received September 04, 2013)

1095-42-249 **Mark Lewko*** (mlewko@gmail.com). *Finite Field Restriction Estimates.*

The Kakeya and restriction conjectures are two of the central open problems in Euclidean Fourier analysis (with the second logically implying the first, and progress on the first typically implying progress on the second). Both of these have formulations over finite fields. In 2008 Dvir completely settled the finite field Kakeya conjecture, however neither his result nor the proof method have yet yielded any progress on the finite field restriction conjecture. In this talk I will describe some recent progress on the finite field restriction conjecture, improving the the exponents of Mockenhaupt and Tao. The key new ingredient is the use of incidence / sum-product estimates. (Received September 10, 2013)

1095-42-258 **J. Marshall Ash*** (mash@math.depaul.edu), Department of Mathematics, DePaul University, Chicago, IL 60614. *How the theory of uniqueness for multiple trigonometric series was formed.*

In 1870, Georg Cantor proved that if a trigonometric series converges to zero at every real number, then all if its coefficients must be zero. A lot of research has gone into attempting to extend this result to multiple trigonometric series. The first really important result in this direction was found by Victor Shapiro in 1957. I will outline what has been done since then. I will also point out several fundamental questions that remain unsolved. (Received September 10, 2013)

43 ► Abstract harmonic analysis

1095-43-273 **L. H. Harper*** (harper@math.ucr.edu), Department of Mathematics, University of California-Riverside, Riverside, CA 92521, Riverside, CA 92521. *Harmonic Analysis and Combinatorics.*

Over millenia mathematics has shifted focus from computation to logic and back a number of times. Joseph Fourier's work, solving differential equations for heat flow and vibrating strings came near the end of the golden age of calculus. Victor Shapiro, in his Faculty Research Lecture at UCR, observed that Georg Cantor's work on convergence of Fourier series led Cantor to set theory. Set theory, though it resolved apparent paradoxes about infinite sets, was controversial in the 19th century because it used nonconstructive methods and threatened to produce new paradoxes. In the twentieth century Turing and Godel used Cantor's diagonal method to give deep insights into the nature of computation and proof. Others however, sought refuge from the axiom of choice in constructive and finitistic mathematics such as combinatorics. The author will present several applications of harmonic analysis to solve combinatorial problems. (Received September 10, 2013)

46 ► Functional analysis

1095-46-13 **Arthur G Shapiro*** (arthur.shapiro@american.edu), Department of Psychology, American University, Washington, DC 20016. *Visual Illusions Related to Harmonic Analysis.*

Harmonic analysis is crucial for understanding how the brain turns a visual image into visual perception. The brain uses a process analogous to Fourier analysis to decompose the visual image into the frequency domain. The question I will address concerns how the brain is able to select the appropriate frequency range even though our eyes are constantly moving. To illustrate the answers to this problem, I will present a number of visual illusions created in my laboratory that arise when information at different frequency ranges are juxtaposed relative to each other. The results highlight the brain's strategies for making sense of a complex environment. (Received May 24, 2013)

1095-46-118 **Asuman G. Aksoy*** (aaksoy@cmc.edu), Claremont, CA 91711, and **Zair Ibragimov** (zibragimov@fullerton.edu), Fullerton, CA 92831. *The Urysohn Universal Space and Hyperconvexity.* Preliminary report.

In a paper published posthumously, Pavel Samuilovich Urysohn constructed a complete, separable metric space that contains an isometric copy of every complete separable metric space. In this talk we examine the relationships between the Uryshon universal space, the notion of hyperconvexity and Isbell's construction of hyperconvex hull of metric spaces. We prove that the Uryshon universal space is hyperconvex. (Received September 04, 2013)

1095-46-178 **Hafedh Herichi*** (herichi@math.ucr.edu), Department of Mathematics, University of California, Riverside, Riverside, CA 92521, and **Michel. L. Lapidus** (lapidus@math.ucr.edu), Department of Mathematics, University of California, Riverside, Riverside, CA 92521. *The spectral operator for fractal strings and a quantization of the universality of the Riemann zeta function.*

The spectral operator, a map that sends the geometry of fractal strings onto their spectrum, was 'heuristically' introduced by M. L.Lapidus and M. van Frankenhuijsen in their development of their theory of complex dimensions of fractal strings. A rigorous functional analytic framework for the study of the spectral operator was provided later on by M. L. Lapidus and H. Herichi. In this talk, we show that any non-vanishing holomorphic function of the truncated infinitesimal shifts of the real line can be approximated by imaginary translates of a suitable family of truncated spectral operators. This latter result provides a 'natural quantization' of Voronin's theorem on the universality of the Riemann zeta function.We conclude that arbitrarily small scaled copies of the spectral operator are encoded within itself. Henceforth, we deduce that the spectral operator can emulate any type of complex behavior and that it is fractal and chaotic. (Received September 09, 2013)

1095-46-264 **Buthinah A. Bin Dehaish*** (bbindehaish@yahoo.com), Department of Mathematics, Faculty of Science For Girls, King Abdulaziz, Jeddah, 21593, Saudi Arabia., Jeddah, Saudi Arabia. *On The Convergence of Iteration for Mappings on Nonlinear Metric Spaces.*

Let (M, d) be a complete 2-uniformly convex metric space, C be a nonempty, bounded, closed, and convex subset of M, and T be an asymptotic pointwise nonexpansive self mapping on C. In this talk, we will define the the modified Ishikawa iteration process in M. i.e.,

$$x_{n+1} = t_n T^n \Big(s_n T^n(x_n) \oplus (1 - s_n)(x_n) \Big) \oplus (1 - t_n) x_n$$

Moreover, under certain and different conditions, we prove that the Ishikawa iteration process converges in a weaker sense to a fixed point of T.
(Received September 10, 2013)

47 ► Operator theory

1095-47-232 **Mohamed A Khamsi*** (mohamed@utep.edu), Department of Mathematics, 500 West University Ave., el paso, TX 79912, and **Buthinah A Bin Dehaish** (bbindehaish@yahoo.com), , Saudi Arabia. *On Convergence of Random Products of Mappings in Metric Spaces.*

Many problems in mathematics and physical sciences uses a technique known as search for a common fixed point. Indeed let X be a set and suppose $T_1, ..., T_N$ are pairwise distinct self-mappings of some closed nonempty subset D of X. Suppose further that the set of fixed points, $Fix(T_i) = \{x \in D : T_i(x) = x\}$, of each mapping T_i is nonempty and that $C = Fix(T_1) \cap \cdots \cap Fix(T_N) \neq \emptyset$. The aim is to find a common fixed point of these mappings.

One frequently employed approach is the following:

Let $r : \mathbb{N} \to \{1, ..., N\}$ be a random mapping, i.e. a surjective mapping that takes each value in $\{1, ..., N\}$ infinitely often. Then generate a random sequence $(x_n)_n$ by taking $x_0 \in D$ arbitrary, and

$$x_{n+1} = T_{r(n)}(x_n), \quad n = 0, 1, \cdots$$

In this talk, we will discuss the convergence of this sequence. (Received September 10, 2013)

1095-47-253 **Waleed K. Al-Rawashdeh*** (walrawashdeh@mtech.edu), Montana Tech, Department Of mathematical Sciences, 1300 W. Park Street, Butte, MT 59701. *Weighted Composition Operators between Weighted Bergman and S^p Spaces.*

Let φ be an analytic self-map of open unit disk $\mathbb{D}$ and ψ is analytic on $\mathbb{D}$. The weighted composition operator induced by φ with weight ψ is given by $\left(W_{\psi,\varphi}f\right)(z) = \psi(z)f(\varphi(z))$, for z in $\mathbb{D}$ and f analytic on $\mathbb{D}$. For each $p \geq 1$, let S^p be the space of analytic functions on $\mathbb{D}$ whose derivatives belong to the Hardy space H^p. For $\alpha > -1$ and $p > 0$ the weighted Bergman space A^p_α consists of all analytic functions in $L^p(\mathbb{D}, dA_\alpha)$, where $dA_\alpha(z) = \frac{(1+\alpha)}{\pi}\left(1-|z|^2\right)^\alpha dA(z)$ is the normalized weighted area measure. In this talk, we characterize boundedness and compactness of weighted composition operators act between weighted Bergman A^p_α and S^q spaces for $1 \leq p, q \leq \infty$. (Received September 10, 2013)

49 ► Calculus of variations and optimal control; optimization

1095-49-110 **Braxton Osting*** (braxton@math.ucla.edu), Department of Mathematics, 405 Hilgard Avenue, Los Angeles, CA 90095, and **Chris D. White** and **Edouard Oudet**. *Minimal Dirichlet energy partitions for graphs.* Preliminary report.

Motivated by a geometric problem, we introduce a new non-convex graph partitioning objective where the optimality criterion is given by the sum of the Dirichlet eigenvalues of the partition components. A relaxed formulation is identified and a novel rearrangement algorithm is proposed, which we show is strictly decreasing and converges in a finite number of iterations to a local minimum of the relaxed objective function. Our method is applied to several clustering problems on graphs constructed from synthetic data, MNIST handwritten digits, and manifold discretizations. The model has a semi-supervised extension and provides a natural representative for the clusters as well. (Received September 03, 2013)

51 ► Geometry

1095-51-24 **William A Kirk*** (william-kirk@uiowa.edu), Department of Mathematics, University of Iowa, Iowa City, IA 52242. *Some Remarks on Fixed Point Theory in Geodesic Spaces.* Preliminary report.

This will be a brief review of some of the speaker's results in metric fixed point theory which are couched within the framework of certain geodesic spaces. The time frame of the survey is from 1964 to the present. The settings include the G-spaces of Busemann, the CAT(0) spaces of Gromov, and metric trees (R-trees). Most of the talk will be expository, but some new results will also be discussed. (Received August 05, 2013)

1095-51-51 **Li-Sheng Tseng*** (lstseng@math.uci.edu). *Symplectic Cohomologies of Differential Forms.*

I will discuss and report on some recent results related to cohomologies of differential forms on symplectic manifolds. (Received August 23, 2013)

1095-51-78 **Sixian Jin*** (sixian.jin@cgu.edu) and **Asuman Aksoy**. *The Equivalence of the Definitions.* Preliminary report.

The equivalence of the definition for metric trees and for δ-hyperbolic spaces has always been assumed in the literature. Here we give a proof that these definitions are equivalent, and identify some fundamental geometric and metric properties of these spaces and their relation to CAT(κ)-spaces. (Received September 06, 2013)

1095-51-131 **Ayaka Shimizu*** (shimizu1984@gmail.com), Department of Mathematics, Gunma National College of Technology, 580 Toriba-cho, Maebashi-shi, Gumma, 3718530, Japan, **Kenta Hayano**, Department of Mathematics, Osaka University, 1-1 Machikaneyamacho, Toyonaka, Osaka, 5600043, Japan, and **Reiko Shinjo**, School of Science and Engineering, Kokushikan University, 4-28-1 Setagaya, Setagaya-ku, Tokyo, 1548515, Japan. *Region crossing change on spatial graphs.*

Region crossing change at a region of a knot, link or spatial-graph diagram is the crossing changes at all the crossings on the boundary of the region. In this talk, we show that we can make any crossing change on any spatial-graph diagram which has no separating circles by a finite number of region crossing changes. (Received September 06, 2013)

1095-51-189 **Yoshiro Yaguchi*** (yaguchi1984@gmail.com), Minamicyou 1-1-6, 6-202, Maebashi, Gunma 371-0805. *Classification of cords on a 3-punctured disk.* Preliminary report.

A cord is a simple curve on a punctured disk, which connects two punctures. The set of isotopy classes of cords forms a rack with the operation called "disk twist", and has applications to two-dimensional braid theory. In this talk, we prove that isotopy classes of cords on a 3-punctured disk are completely parameterized by 3 non-negative numbers. For the proof of it, we introduce the "diagram" which is a disjoint union of segments in a gon to represent an isotopy classe of a cord. (Received September 09, 2013)

1095-51-218 **Raquel Perales*** (praquel@math.sunysb.edu), Department of Mathematics, Stony Brook University, Stony Brook, NY 11790, and **Christina Sormani** (sormanic@member.ams.org). *Glued Limit Spaces of Noncollapsing Sequences of Riemannian Manifolds.*

We will consider noncollapsing sequences of m-dimensional Riemannian manifolds with nonnegative Ricci curvature. To define a reasonable notion of a limit of such a sequence, we examine δ inner regions which avoid the boundary by a distance δ, where the boundary of a manifold is defined as the metric completion of the manifold minus the manifold. Here the boundary is not necessarily smooth.

We prove Gromov-Hausdorff compactness theorems for sequences of δ inner regions. Out of these limits we build "glued limit spaces". Then show that glued limit spaces have Hausdorff dimension m and its Hausdorff measure has positive lower density everywhere. (Received September 09, 2013)

1095-51-223 **Pedro A Solorzano*** (solorzano@math.ucr.edu), Department of Mathematics, UC Riverside, 900 University Ave, Riverside, CA 92521. *Collapse and waning.* Preliminary report.

Tangency is followed in the Gromov-Hausdorff sense over a sequence of metrics on the total space of a principal G-bundle, where G is a compact Lie group and the metrics are a connection metric transformed under a Cheeger deformation collapsing the fibers.

The interesting example of the Berger spheres will be analyzed, and it will hint the general behavior as well as a departure from the intrinsic notion of tangency in the limit—i.e. the base space. (Received September 09, 2013)

52 ► Convex and discrete geometry

1095-52-179 **J. M. S. Simoes-Pereira*** (siper@mat.uc.pt), 153 Courtney Street, Newark, DE 19711. *Finite Alignments, Topologies and Convex Geometries.*

My aim is to point out the relevance of alignments. They are not receiving the attention they deserve. Alignments generalize topologies. Only a special type, the convex geometries stricto sensu, has been widely investigated mainly because of its role in graph theory. Note that convex geometries stricto sensu do not generalize topologies. We characterize alignments which are topologies, we describe how basic concepts of topological spaces, such as neighborhood, and interior, exterior or boundary of a set may be extended to alignment spaces; we look also into concepts largely used in alignments, such as extreme points, derived sets and Higgs spaces, and compare them with their analogues in topologies. (Received September 08, 2013)

53 ► Differential geometry

1095-53-8 **Xiaoyang Chen*** (xchen3@nd.edu). *Riemannian submersions from compact four manifolds.*

We show that there is no nontrivial isoparametric Riemannian submersion from any compact four manifold with positive sectional curvature. This gives a partial answer to a conjecture due to Fred Wilhelm. We also classify two-dimensional Riemannian submersions from compact four-dimensional Einstein manifolds with totally geodesic fibers. (Received April 22, 2013)

1095-53-32 **Denis Auroux*** (auroux@math.berkeley.edu), Department of Mathematics, University of California, 970 Evans Hall # 3840, Berkeley, CA 94720-3840. *Mirror symmetry for some affine hypersurfaces.* Preliminary report.

We will discuss formulations of mirror symmetry for a hypersurface H in $(\mathbb{C}^*)^n$ from two different viewpoints: the Strominger-Yau-Zaslow (SYZ) conjecture on one hand, and homological mirror symmetry on the other. To make things concrete, we will illustrate all the statements on a simple example: the pair of pants, viewed as a hypersurface in $(\mathbb{C}^*)^2$.

From the SYZ perspective, in recent work with M. Abouzaid and L. Katzarkov we have studied the enumerative geometry of Lagrangian tori in blowups of $(\mathbb{C}^*)^n \times \mathbb{C}$ along $H \times 0$ to derive a construction of a Landau-Ginzburg model that can be viewed as a mirror to H.

From the homological mirror symmetry perspective, in the case where $n = 2$ and H has genus 0, joint work with Abouzaid, Efimov, Katzarkov and Orlov shows that the wrapped Fukaya category of H is equivalent to the derived category of singularities of this mirror; these results are being extended by H. Lee to other Riemann surfaces. Finally, joint work in progress with Abouzaid relates the derived category of coherent sheaves of H to a certain Fukaya category of the mirror. (Received August 19, 2013)

1095-53-44 **Qi S. Zhang*** (qizhang@math.ucr.edu), Riverside, CA 92521. *A No breathers theorem for some noncompact Ricci flows.*

Under suitable conditions near infinity and assuming boundedness of curvature tensor, we prove a no breathers theorem in the spirit of Ivey-Perelman for some noncompact Ricci flows. These include Ricci flows on asymptotically flat (AF) manifolds with positive scalar curvature, which is connected to the problem of irreversibility of world sheet in string theory. Since the method for the compact case faces a difficulty, the proof involves solving a new non-local elliptic equation which is the Euler-Lagrange equation of a scaling invariant log Sobolev inequality. (Received August 23, 2013)

1095-53-45 **Ovidiu Munteanu*** (ovidiu.munteanu@uconn.edu), University of Connecticut, Storrs, CT 06268. *Topology at infinity of Ricci solitons.*

We present some joint work with Jiaping Wang about the number of ends of gradient Ricci solitons. (Received August 23, 2013)

1095-53-46 **Catherine E Searle*** (searleca@math.oregonstate.edu), Department of Mathematics, 368 Kidder Hall, Oregon State University, Corvallis, OR 97331, and **Fred Wilhelm** (fred@math.ucr.edu), Mathematics Department, 900 University Avenue, UC Riverside, Riverside, CA 92521. *Lifting Positive Ricci Curvature.*

We show how to lift positive Ricci and almost non-negative curvatures from an orbit space M/G to the corresponding G-manifold, M. We apply the results to get new examples of Riemannian manfiolds that satisfy both curvature conditions simultaneously. This is joint work with Fred Wilhelm. (Received August 23, 2013)

1095-53-48 **Zhuang-dan Daniel Guan*** (zguan@math.ucr.edu), Department of Mathematics, University of California at Riverside, Riverside, CA 92521. *Classification of Real Eight Dimensional Compact Solvmanifolds with Real Symplectic Structures.* Preliminary report.

In 2006, we solved the problem of calculating the cohomology of compact solvmanifolds. That made the classification of the compact solvmanifolds with symplectic structure possible. In 2010, we were able to classify real six dimensional compact solvmanifolds with real symplectic structures and gave a method to handle the higher dimensional cases. In the earlier part of 2013, we classified the real eight dimensional non-nilpotent compact solvmanifolds with real symplectic structures. In particular, we found that the commutator of the nilradical is abelian. This confirmed a conjecture we mentioned for the non-nilpotent eight dimensional case. A refinement of the 2006 work was obtained, which was partially announced in the classification of pseudokähler compact complex solvmanifolds. Our method was also applied to the holomorphic symplectic or hypersymplectic cases. (Received September 09, 2013)

1095-53-49 **Lee Kennard*** (kennard@math.ucsb.edu). *Two children of the Chern conjecture.* Preliminary report.

A conjecture of Chern concerns fundamental groups of Riemannian manifolds with positive sectional curvature. It is now known to be false. We will review the the statement of, the evidence for, and the counterexamples to the conjecture. In the presence of symmetry, there are positive statements related to the conjecture. We state two modified conjectures with symmetry (one of which is sharp with respect to the symmetry assumption) and provide evidence for both. (Received August 23, 2013)

1095-53-61 **Guangbo Xu*** (guangbox@math.princeton.edu), 410N Rowland Hall, University of California, Irvine, Irvine, CA 92697. *Gauged Floer theory for Hamiltonian isotopies.*

Hamiltonian Floer theory, invented by Floer, was a great breakthrough in understanding the topology of symplectic manifolds. For example, it provides a systematic approach to the solution of the famous Arnold conjecture on the number of fixed points of a Hamiltonian isotopy. However, the definition and the computation of the Floer homology groups require a lot of sophisticated analysis, most notably the use of the "virtual technique".

The presenter will talk about a new approach in defining certain Hamiltonian Floer homology groups, which will bypass the hard analysis in many important examples. This approach was proposed by Cieliebak-Gaio-Salamon, which is the "gauged sigma-model" lift of the usual Hamiltonian Floer theory. Its relation with the usual Hamiltonian Floer theory, which is realized by the adiabatic limit process, will also be discussed. (Received August 26, 2013)

1095-53-79 **Hyunjoo Cho**, **Sema Salur** and **Albert J. Todd*** (ajtodd@math.ucr.edu). *Remarks on Hamiltonian Structures and G_2-Geometry.*

I will begin by discussing the basic properties of multisymplectic manifolds, defined using a natural generalization of symplectic 2-forms from symplectic geometry to general closed n-forms satisfying a nondegeneracy condition, and Hamiltonian multivector fields and differential forms on such manifolds based on work of Cantrijn, Ibort and de León. I will then give a short introduction to G_2-geometry as a specific example of a multisymplectic geometry and make a number of remarks about Hamiltonian structures on a manifold with an integrable G_2-structure. (Received August 28, 2013)

1095-53-101 **Bingyu Song** (bysong@mail.ccnu.edu.cn), School of Mathematics and Statistics, Central China Normal University, Wuhan 430079, Peoples Rep of China, **Guofang Wei*** (wei@math.ucsb.edu), Math Department, UCSB, Santa Barbara, CA 93106, and **Guoqiang Wu**, Department of Mathematics, University of Science and Technology of China, Peoples Rep of China. *Monotonicity Formulas for Bakry-Emery Ricci Curvature.*

Motivated and inspired by the recent work of Colding and Colding-Minicozzi we derive several families of monotonicity formulas for manifolds with nonnegative Bakry-Emery Ricci curvature, extending the formulas in Colding, Colding-Minicozzi. (Received September 03, 2013)

1095-53-107 **Maree Jaramillo***, Department of Mathematics, University of California, Santa Barbara, Santa Barbara, CA 93106. *Fundamental Groups of Spaces with Bakry-Emery Ricci Tensor Bounded Below.*

The Bakry-Emery Ricci tensor is a natural extension of Ricci curvature on smooth metric measure spaces. Since topological and geometric information can be obtained for manifolds with Ricci curvature bounded from below, it is natural to ask if the same information holds true for smooth metric measure spaces with Bakry-Emery Ricci tensor bounded from below. Using Guofang Wei and Will Wylie's comparison theorems and an extension of Kevin Brighton's gradient estimate on smooth metric measure spaces, we extend the Almost Splitting Theorem of Cheeger-Colding to the smooth metric space setting. Using this Almost Splitting theorem, we show that the fundamental group of the smooth metric measure space with a lower bound on volume has almost abelian fundamental group. We also show that the number of generators of the fundamental group of a smooth metric measure space with Bakry-Emery Ricci tensor bounded from below is uniformly bounded. The results on the fundamental group are extensions of theorems which hold for Riemannian manifolds with Ricci curvature bounded from below. (Received September 03, 2013)

1095-53-112 **Ye-Lin Ou*** (yelin.ou@tamuc.edu). *Some recent progress on biharmonic maps and biharmonic submanifolds.*

Biharmonic maps are maps between Riemannian manifolds that minimize the bi-energy functional. Biharmonic sumanifolds are submanifolds whose defining isometric immersions are biharmonic maps. Biharmonic maps generalize the notion of harmonic maps whilst biharmonic submanifolds include minimal submanifolds as a subclass. In this talk we will review some basic examples of biharmonic maps, some fundamental problems in the study of biharmonic maps, and then we will focus on some recent progress on Chen's conjecture and the generalized Chen's conjecture on biharmonic submanifolds. This includes our counter examples to show that the generalized Chen's conjecture is false. (Received September 03, 2013)

1095-53-113 **Jeffrey Streets*** (jstreets@uci.edu). *Long time existence of minimizing movement solutions of Calabi flow.*

In 1982 Calabi proposed studying gradient flow of the L^2 norm of the scalar curvature (now called Calabi flow) as a tool for finding canonical metrics within a given Kahler class. The main motivating conjecture behind this flow (due to Calabi-Chen) asserts the smooth long time existence of this flow with arbitrary initial data. By exploiting aspects of the Mabuchi-Semmes-Donaldson metric on the space of Kahler metrics I will construct a kind of weak solution to this flow, known as a minimizing movement, which exists for all time. (Received September 04, 2013)

1095-53-157 **Arlo Caine*** (jacaine@csupomona.edu). *Equivalence of Demazure and Bott-Samelson Resolutions via Factorization.* Preliminary report.

There are two models of the generalized flag manifold of a complex semi-simple Lie group G: the complex quotient $X = G/B^+$ and the real quotient K/T. The inclusion of K into G induces a diffeomorphism $K/T \to G/B^+$. Schubert varieites $\overline{X_w} = \overline{B^+wB^+/B^+}$ in G/B^+, which are often singular, can then be studied as complex algebraic subvarieties of G/B^+, or as topological subspaces of K/T. Given a reduced word decomposition of the indexing Weyl group element w, Bott and Samelson constructed a resolution BS_w of the Schubert variety, considered as a subset of K/T. Shortly thereafter, Demazure produced a similar construction of a resolution DBS_w of the Schubert variety as a complex algebraic subvariety of G/B^+. Examining the constructions, there is an obvious map which induces a diffeomorphism $BS_w \to DBS_w$. The main result of this work is an explicit formula for the inverse of this map involving an iterated composition of factorization, multiplication, and inversion maps on G. The application is to the construction of Darboux coordinates for an integrable system on X_w. (Received September 07, 2013)

1095-53-240 **Yun Myung Oh*** (ohy@andrews.edu), Mathematics Department, 4260 Administration Dr., Berrien Springs, MI 49104. *An inequality on Riemannian submersion and θ-slant submanifold.*

It has been known that if a Riemannian manifold admits a non-trivial Riemannian submersion with totally geodesic fibers, then it cannot be isometrically immersed in any Riemannian manifold of non-positive sectional curvature as a minimal submanifold. B.Y. Chen proved this using an inequality involving the submersion invariant and his inequality shows the upper bound of the invariant $\check{A}_\pi$ if a manifold is Lagrangian submanifold. Recently, the lower bound was found and furthermore, another inequality can be derived if we consider a θ-slant submanifold in complex space forms. (Received September 10, 2013)

54 ► General topology

1095-54-166 **Aaron Kaestner*** (amkaestner@northpark.edu), 3225 West Foster Avenue, Campus Box: 07, Chicago, IL 60625, and **Louis H. Kauffman** and **Heather A. Dye**. *Khovanov Homology for Virtual Knots.*

We discuss a construction for calculating Khovanov homology for virtual knots with integral coefficients along with potential applications for this construction. This construction is equivalent to that defined by V.O. Manturov. This work is joint with Louis H. Kauffman and Heather A. Dye. (Received September 08, 2013)

1095-54-269 **Ellie Anne Grano*** (ellie.grano@pepperdine.edu), 17311 Castellammare Dr., Apt. 2E, Pacific Palisades, CA 90272. *The pop-switch planar algebra and the Jones-Wenzl projections.* Preliminary report.

The pop-switch planar algebra is a new planar algebra containing the Temperley-Lieb planar algebra. It is motivated by Jones' idea of the "graph planar algebra" of type A_n. Complicated calculations using the graph planar algebra can be done pictorially in this new planar algebra.

The Jones-Wenzl projections are important elements of the Temperley-Lieb planar algebra, yet are very complicated to write down. Viewing the pop-switch planar algebra as a matrix category, the Jones-Wenzl projections are direct sums of very simple diagrams. I will present this new planar algebra and discuss this method of viewing the Jones-Wenzl projections. (Received September 10, 2013)

55 ► Algebraic topology

1095-55-64 **Hiro Lee Tanaka*** (htanaka@math.northwestern.edu). *Algebraic K Theory, Bridgeland Stability Conditions, and Factorization Homology over the Circle.*

I'll describe some work in progress that relates all three of the ideas in the title. We first prove that for any reasonable category (like the derived category of coherent sheaves on some curve) there is a family of maps from the moduli space of Bridgeland stability conditions to a certain configuration space of points on the circle. This particular configuration space, the Ran space of the circle, has shown up in manifold calculus and in factorization homology, and is a convenient way to encode information about the Aoo operad. By pondering what information this family of maps might encode, we can construct a family of spaces living over the space of stability conditions, and each family member embeds into the algebraic K theory space of the category, along with a filtration of algebraic K theory. Moreover, each of these spaces seems to define a cosheaf over the Ran space of the circle.

There are many families appearing, and it is natural to ask what these various families can tell us about the moduli space of stability conditions, or about Algebraic K Theory. No obvious answers have arisen yet, so most of the talk will be focused on the construction of everything I've mentioned. (Received August 26, 2013)

1095-55-99 **Andrew Salch*** (asalch@math.wayne.edu). *Arithmetic classification of finite odd-primary E(1)-local spectra.* Preliminary report.

Let p be an odd prime and let E(1) be p-primary height 1 Johnson-Wilson homology.

1. We produce a totally explicit classification of all E(1)-local stable homotopy types of finite CW-complexes. We then run the E(1)-local Adams-Novikov spectral sequence for each of these stable homotopy types to compute the E(1)-local stable homotopy groups of all finite CW-complexes.

2. We use the above classification together with the theory of F-crystals to associate, to each finite CW-complex, a p-adic Galois representation–that is, a finitely generated Z_p-module equipped with an action by the absolute Galois group of Q_p. We then show that the E(1)-local stable homotopy type of the CW-complex can be recovered from the Galois representation, and we demonstrate some relationships between the orders of the E(1)-local stable homotopy groups of the CW-complex and special values of a p-local Euler factor associated to the F-crystal. We will try to argue that this should be thought of as a kind of "topological Artin reciprocity."

3. If there's time remaining, we demonstrate some work in progress: using the above to prove the E(1)-local generating hypothesis; and doing the same things at height 2. (Received September 02, 2013)

1095-55-245 **Steven Greg Chadwick*** (chadwick@math.ucr.edu). *Structured Complex Orientations.*

When does a map of ring spectra from the complex cobordism spectrum MU to itself refine to a map of E_∞ ring spectra? Every map of ring spectra from MU to itself refines to an E_2 map. Consequently Quillen's map lifts to an E_2 map and hence the Brown-Peterson spectrum BP admits an E_2 ring structure. However not every self map of MU is E_∞; there exist ring maps from MU to itself that do not refine to E_4 maps. (Received September 10, 2013)

1095-55-248 **Saul Coleman Glasman*** (sglasman@math.mit.edu), 100 Memorial Drive, Apt. 11-1B, Cambridge, MA 02142. *The multiplicative Barratt-Priddy-Quillen theorem and beyond.*

The Barratt-Priddy-Quillen theorem, arguably one of the most striking in topology, states that the K-theory of the category of finite sets is equivalent to the sphere spectrum. We'll state and prove a multiplicative analog of the theorem, giving a simple category whose K-theory can be identified with the free E_∞ ring spectrum on one generator. If time permits, we'll discuss the combinatorics of divided power spectra and other future directions. (Received September 10, 2013)

57 ► Manifolds and cell complexes

1095-57-27 **Oliver Dasbach** and **Adam Lowrance*** (adlowrance@vassar.edu). *Khovanov homology of oriented ribbon graphs.*

The all-A ribbon graph of a link diagram is an oriented ribbon graph related to the checkerboard graph of the diagram. We construct Khovanov homology for oriented ribbon graphs and show that the Khovanov homology of the all-A ribbon graph of a link diagram is isomorphic to the Khovanov homology of the link. We extend our results for certain virtual links. (Received August 12, 2013)

1095-57-41 **Louis H. Kauffman*** (kauffman@uic.edu), 5530 South Shore Drive, Apt. 7C, Chicago, IL 60637-1946. *Elements of Khovanov Homology.*

This is a talk about the basics of Khovanov homology. We show how the Frobenius algebra related to this homology arises naturally from starting with the Bar-Natan viewpoint of a chain homotopy cobordism category. We look at the structure of the homology theory in relation to higher categories by initiating an arrow algebra that allows $(a \longrightarrow b)^n$ to unfold into the n-cube category, but also into various higher categories depending upon the interpretations of the arrows. This leads to speculations about the physical meaning of Khovanov homology in terms of quantum statistical mechanics. (Received August 22, 2013)

1095-57-43 **Kanako Oshiro*** (oshirok@sophia.ac.jp), Sophia University, 7-1 Kioi-cho, Chiyoda-ku, Tokyo, 102-8554, Japan. *Linear Alexander quandle colorings and finite-fold cyclic covers of S^3 branched over knots.*

The Fox-colorings of a knot are interpreted as the group representations from the fundamental groups of the 2-fold cyclic cover of S^3 branched over the knot to $\mathbb{Z}_p$. The interpretation is extended for linear Alxander quandle colorings by using some condition. (Received August 22, 2013)

1095-57-56 **Scott Carter** and **Seiichi Kamada*** (skamada@sci.osaka-cu.ac.jp), Department of Mathematics, Osaka City University, 3-3-138, Sugimoto, Sumiyoshi, Osaka, Osaka 558-8585, Japan. *Charts for 3-dimensional braids.*

We introduce the notion of a 3-dimensional braid and its chart description. A 3-dimensional braid is a compact oriented 3-manifold embedded or immersed in the 5-disk, which is a generalization of a classical braid and a 2-dimensional braid. A higher dimensional braid can be also defined. We show how to describe a 3-dimensional braid by using a 1-parameter family of charts. Furthermore, a 2-parameter family of charts can describe a 4-dimensional braid. (Received August 25, 2013)

1095-57-71 **Hao Wu*** (haowu@gwu.edu), Department of Mathematics, George Washington University, Monroe Hall, Room 240, 2115 G Street, NW, Washington, DC 20052. *A Family of Transverse Link Homologies.*

I will talk about the Khovanov-Rozansky homology with potential ax^{N+1}. For $N \geq 1$, this is an invariant for transverse links in the standard contact S^3, but not for smooth links. I will also discuss its decategorification and its relation to the $\mathfrak{sl}(N)$ Khovanov-Rozansky homology. (Received August 27, 2013)

1095-57-74 **Allison K Henrich*** (henricha@seattleu.edu), 901 12th Ave, PO Box 222000, Seattle, WA 98122. *Pseudoknots, Classical and Virtual.*

Pseudoknots are equivalence classes of knot diagrams that may be missing some crossing information. Equivalently, pseudoknots can be thought of as decorated chord diagrams modulo chord-diagrammatic Reidemeister-type equivalence relations. This second formulation immediately gives rise to a notion of virtual pseudoknots. In this talk, we will explicitly define classical and virtual pseudoknots and introduce several new invariants of these objects. (Received August 28, 2013)

1095-57-89 **Naoko Kamada*** (kamada@nsc.nagoya-cu.ac.jp), Graduate School of Natural Sciences, Nagoya City University, 1 Yamanohata, Mizuho-cho, Mizuho-ku, Nagoya, Aichi 467-8501, Japan. *Surface pole-bracket polynomials of virtual knots and twisted knots.*

Dye and Kauffman defined a surface bracket polynomial for a virtual knot diagram, or a knot diagram on a closed oriented surface, that is a linear sum of states on a surface whose coefficients are one-variable polynomials, and it dominates the f-polynomial. On the other hand, Dye and Kauffman, and Miyazawa introduced the multi-variable polynomial invariant (the DKM polynomial), which is a refinement of the f-polynomial. First we generalize the surface bracket polynomial so that the states on a surface may have some poles, called pole-states on a surface, and it dominates the DKM polynomial. We call it the surface pole-bracket polynomial. The second result is on a twisted knot. The notion of a twisted knot, introduced by Bourgoin, is a non-orientable version of a virtual knot. A twisted knot corresponds in general to the stable equivalence class of a knot in the twisted I-bundle over a non-orientable surface. The f-polynomial and the DKM polynomial were also defined for a twisted knot diagram by Bourgoin and the author. In this talk, we also consider the surface pole-bracket polynomial for a twisted knot diagram or a knot diagram on a closed non-orientable surface. (Received August 31, 2013)

1095-57-97 **W. Edwin Clark**, **Mohamed Elhamdadi**, **Masahico Saito*** (saito@usf.edu) and **Timothy Yeatman**. *Some aspects of quandle colorings for knots and applications.* Preliminary report.

A summary and some curious facts are presented about computational results of quandle colorings for the knot table. The list of connected quandles up to order 35 was obtained by Vendramin. Their various properties are discussed, and their numbers of colorings are computed for knots in the table. Quandles that distinguish mirror images are discussed, and relations to other knot invariants are examined. Problems and conjectures that arose from these computations are presented. (Received September 02, 2013)

1095-57-105 **Alexander Hulpke** (hulpke@math.colostate.edu), Department of Mathematics, Colorado State University, Fort Collins, CO, **David Stanovský** (stanovsk@karlin.mff.cuni.cz), Department of Algebra, Charles University, Prague, Czech Rep, and **Petr Vojtěchovský*** (petr@math.du.edu), Department of Mathematics, University of Denver, Denver, CO. *Connected quandles and transitive groups.* Preliminary report.

Using ideas of Galkin, we establish a one-to-one correspondence between connected quandles and certain configurations in transitive groups. Among the consequences, we find minimal representations for connected quandles and we give a new proof of a recent result of McCarron that there are no connected quandles of order $2p$, $p > 5$. (Received September 04, 2013)

1095-57-151 **Jozef H. Przytycki*** (przytyck@gwu.edu), Department of Mathematics, George Washington University, Washington, DC 20 052. *Homology of Yang-Baxter operators.*

I describe my recent work on homology of Yang Baxter operations and its potential connection to Khovanov homology of some families of links. The logical line is as follows: Jones polynomial and Homflypt polynomial can be described using the well-understood Yang-Baxter operators (as shown by Jones and Turaev). Khovanov homology categorifies the Jones polynomial (or the Kauffman bracket polynomial), and Khovanov-Rozansky homology categorifies the Homflypt polynomial. The Yang-Baxter equation can be thought of as a generalization of self-distributivity: that is, a binary operation $* : X \times X \to X$, is lifted to the linear operator $Y : RX \otimes RX \to RX$, where $R(a, b) = (b, a*b)$); if $*$ is right self-distributive then R satisfies the Yang-Baxter equation. Distributive homology (including rack homology and quandle homology) can be generalized to homology of set-theoretical Yang-Baxter operator (as showed by Carter, Elhamdadi, and Saito). Eiserman and Lebed considered homology of more general Yang-Baxter operators. Furthermore, Hochschild homology can be described by a graphical calculus in a similar way as distributive homology. Khovanov homology and Hochschild homology are closely related. (Received September 07, 2013)

1095-57-172 **Uwe Kaiser*** (ukaiser@boisestate.edu), Department of Mathematics, Boise State University, 1910 University Drive, Boise, ID 83725. *On Extended Bar-Natan Skein Modules.* Preliminary report.

Let M be an oriented 3-manifold. For R a commutative Frobenius algebra, we define the *extended Bar-Natan module* as the quotient of a free $R[A^{\pm 1}]$-module with basis given by pairs (F, L) (up to a suitable notion of isotopy) by both Bar-Natan and Kauffman bracket relations. Here L is a framed link embedded in a regular neighborhood of an orientable surface, which is itself embedded in M. We study the module for some simple 3-manifolds and discuss its relation to the usual Bar-Natan and Kauffman bracket modules. (Received September 08, 2013)

1095-57-213 **Mohamed Elhamdadi*** (emohamed@math.usf.edu), Tampa, FL 33620, **Matthew Green**, Tampa, FL 33620, and **Nacer Makhlouf**, Mulhouse, France. *Ternary Distributive Algebraic Structure.* Preliminary report.

We introduce a notion of Ternary Distributive Algebraic Structure, investigate its properties and relate it to binary distributive structures such as quandles. Examples will be given such as in the context of Ternary Hopf Algebras and Coalgebras. A deformation theory of these structures will be discussed. (Received September 09, 2013)

1095-57-215 **Maciej Niebrzydowski*** (mniebrz@gmail.com). *Knots with binary relations.* Preliminary report.

We consider binary relations on the set of arcs of a given link diagram, together with the condition that an arc b can move over arc a only if aRb. We discuss the consequences of such a condition, including the irreversibility of moves, and using indicators in place of invariants. We consider a similar problem with relations on the set of components, for which we develop a homology of (partial) quandles with binary relations. (Received September 09, 2013)

1095-57-265 **Radmila Sazdanovic*** (rsazdanovic@math.ncsu.edu), Department of Mathematics, North Carolina State University, PO Box 8205, Raleigh, NC 27695, and **Jozef H. Przytycki**. *Torsion in Khovanov homology of semi-adequate links.* Preliminary report.

We will introduce an enhanced version of the chromatic cohomology defined by Y.Rong and L. Helme-Guizon and use it to compute the torsion in Khovanov link homology. This is a step towards proving Shumakovitch's conjecture about the existence of Z_2 torsion in Khovanov homology. (Received September 10, 2013)

58 ► Global analysis, analysis on manifolds

1095-58-42 **Matilde Marcolli*** (matilde@caltech.edu), Department of Mathematics, California Institute of Technology, 1200 E California Blvd, Pasadena, CA 91125, and **Nicolas Tedeschi**. *The multifractal formalism and noncommutative geometry.* Preliminary report.

Spectral triples are used in noncommutative geometry as a generalization of the notion of compact smooth spin manifolds, while quantum statistical mechanical systems provide a somewhat similar framework to study a broad class of noncommutative spaces. We investigate how these structures can be adapted to encode multifractal decompositions of fractal spaces. (Received August 22, 2013)

1095-58-132 **Michael Bradford Williams*** (mwilliams@math.ucla.edu). *Stability of algebraic Ricci solitons under Ricci flow.*

We consider a modified Ricci flow equation whose stationary solutions include Einstein and Ricci soliton metrics, and we study the stability of those solutions under the flow. Our focus is on algebraic solitons, which are left-invariant metrics on solvable Lie groups, and which include all known examples of non-gradient expanding solitons on non-compact manifolds.

For stability, we follow the program of Guenther, Isenberg, and Knopf. After a suitable modification of Ricci flow, one major step is to show that fixed points are linearly stable. We describe joint work with Jablonski and Petersen in which we verify linear stability for many families of algebraic solitons. The other main step is to show dynamical stability. In joint work with Wu, we define a class of weighted little Hölder spaces with certain interpolation properties that allow the use of maximal regularity theory and a stability theorem of Simonett. With this, we show that all linearly stable algebraic soliton metrics are dynamically stable. (Received September 06, 2013)

60 ► Probability theory and stochastic processes

1095-60-17 **Yuichiro Kakihara*** (ykakihar@csusb.edu), 5500 University Parkway, San Bernardino, CA 92407-2393. *Banach space valued second order stochastic processes.* Preliminary report.

Abstract: Banach space valued second order stochastic processes can be recognized as $B(\mathcal{U},\mathcal{H})$-valued processes, where $\mathcal{U}$ is a Banach space and $\mathcal{H}$ is a Hilbert space. These processes are classified by their operator and scalar covariance functions. To describe such processes we use an integral representation with respect to a $B(\mathcal{U},\mathcal{H})$-valued measure, where we develop integration of operator valued functions with respect to such a measure. We focus on characterizing weak operator harmonizable processes in connection with their representing measures, weak scalar harmonizability, operator stationary dilation and operator V-boundedness. This is partly because a weakly operator harmonizable process can be written as a Fourier transform of a $B(\mathcal{U},\mathcal{H})$-valued measure. Finally, processes of operator Cramér class and operator Karhunen class are introduced and characterized. (Received June 27, 2013)

1095-60-65 **Karl Mahlburg*** (mahlburg@math.lsu.edu), Lockett Hall 228, Baton Rouge, LA 70803. *Markov processes, bootstrap percolation, and integer partitions.*

I will describe recent results at the intersection of combinatorial probability, the theory of integer partitions, and number theory. The calculation of metastability thresholds for bootstrap percolation models involves the limiting distribution of an infinite sequence of Markov processes with slowly changing parameters. This calculation is combinatorially equivalent to determining the analytic behavior of integer partitions with gap conditions, and specifically asymptotic formulas. Such formulas are further related to the behavior of certain hypergeometric q-series under modular transformations. In this talk, I will explain the interplay between these disparate threads. (Received August 26, 2013)

1095-60-76 **Persi Diaconis** and **Jason Fulman*** (fulman@usc.edu). *Combinatorics of the carries Markov chain.*

We study the combinatorics of "carries" when adding integers. We give connections with card shuffling and sections of generating functions. We also determine the rate of convergence of the carries chain to stationarity, and give explicit expressions for the left and right eigenvectors of the carries chain. This work is joint with Persi Diaconis. (Received August 28, 2013)

1095-60-158 **Joe P. Chen** and **Baris Evren Ugurcan*** (beu4@cornell.edu), Department of Mathematics, Cornell University, Ithaca, NY 14853. *Entropic repulsion of Gaussian free field on high-dimensional Sierpinski carpet graphs.*

We study the centered Gaussian field on high-dimensional Sierpinski carpet graphs. The covariance of the field is given by the Green's function for the simple random walk on the graph. By assuming that the field is positive everywhere, *i.e.* constrained above a hard wall at zero height, we prove the leading-order asymptotics for the local sample mean of the free field above the hard wall on any transient Sierpinski carpet graph. Our main results extend the results of Bolthausen-Deuschel-Zeitouni for the free field on $\mathbb{Z}^d$, $d \geq 3$, to the fractal setting. Our proof utilizes the theory of transient regular Dirichlet forms, in conjunction with the relative entropy, coarse graining, and conditioning arguments introduced in the previous literature. (Received September 07, 2013)

1095-60-161 **Umit Islak*** (islak@usc.edu), Department of Mathematics, USC 3620 S Vermont, Los Angeles, CA 90089-2532, and **Subhankar Ghosh**. *Multivariate Concentration of Measure Type Inequalities via Size Biased Couplings.* Preliminary report.

Let $\mathbf{W} = (W_1, W_2, ..., W_k)$ be a random vector with nonnegative coordinates having nonzero and finite variances. We prove concentration of measure type inequalities for $\mathbf{W}$ using size biased couplings. These couplings, which originate from Stein's method, were previously used to obtain concentration bounds for univariate random variables. Our results generalize the previous efforts, and two applications on local dependence and counting patterns are provided. (Received September 08, 2013)

1095-60-214 **Laura M. Smith**, **Kristina Lerman**, **Cristina Garcia-Cardona**, **Allon G. Percus*** (allon.percus@cgu.edu) and **Rumi Ghosh**. *Spectral Clustering with Epidemic Diffusion.*

Spectral clustering is widely used to partition graphs into distinct modules or communities. Existing methods for spectral clustering use the eigenvalues and eigenvectors of the graph Laplacian, an operator that is closely associated with random walks on graphs. We propose a new spectral partitioning method that exploits the properties of epidemic diffusion. An epidemic is a dynamic process that, unlike the random walk, simultaneously transitions to all the neighbors of a given node. We show that the replicator, an operator describing epidemic diffusion, is equivalent to the symmetric normalized Laplacian of a reweighted graph, with edges reweighted by the eigenvector centralities of their incident nodes. Thus, more weight is given to edges connecting more central nodes. We describe a method that partitions the nodes based on the componentwise ratio of the replicator's second eigenvector to the first, and compare its performance to traditional spectral clustering techniques on synthetic graphs with known community structure. We demonstrate that the replicator gives preference to dense, clique-like structures, enabling it to more effectively discover communities that may be obscured by dense intercommunity linking. (Received September 09, 2013)

1095-60-262 **Mark L Huber*** (mhuber@cmc.edu), 850 Columbia Avenue, Claremont, CA 91711. *Fast approximation algorithms for partition functions of Gibbs distributions.*

Finding the partition function of Gibbs distributions has applications in model selection and building estimators for parameters of spatial models. This talk will present a new algorithm for estimating these partition functions. The method combines a well balanced cooling schedule created through a technique called TPA and a product importance sampler. One advantage of the algorithm over existing methods is the standard deviation of the estimate can be bounded theoretically. That is to say, unlike most algorithms where the standard deviation must itself be estimated, the standard deviation of this algorithm is fixed ahead of time by the use. The number of samples necessary to build a close estimate grows almost linearly in the logarithm of the partition function, making the approach suitable for high dimensional problems. The samples needed for the estimate can be generated rapidly by methods such as parallel tempering. (Received September 10, 2013)

1095-60-272 **Alan Krinik** and **Satori Schweitz***, Cal Poly Pomona, Department of Mathematics and Statistics, Pomona, CA 91768. *The Single Server Restart Queueing Model.*

Consider the classical single server queueing system having three different types of possible catastrophes represented by new states: -3, -2, -1. The recovery rates from these catastrophes vary and are dependent upon the severity of the occurring catastrophe. When a catastrophe occurs, the system undergoes a restart birth subprocess that leads to the underlying single server system with no customers present. The transient probability functions of this system are determined using dual processes, lattice path combinatorics and randomization. This approach also works to solve systems having similar but more general multiple-catastrophe configurations. (Received September 10, 2013)

1095-60-278 **Kenneth Alexander** and **Gokhan Yildirim*** (gyildiri@usc.edu), USC Dornsife Department of Mathematics, 3620 S. Vermont Ave., KAP 104, Los Angeles, CA 90089. *ON THE DEPINNING TRANSITION OF DIRECTED POLYMERS IN A RANDOM ENVIRONMENT WITH A DEFECT LINE.* Preliminary report.

We study the depinning transition of the directed polymer in a random environment with a defect line model. The monomer locations of the polymer is modeled by the trajectory of a simple symmetric random walk. Random environment is introduced by assigning each site of $\mathbb{Z}^d$ an independent and identically distributed normal random variable that interacts with the polymer when it visits that site. The defect line is incorporated to the model by having a constant potential u at the origin which gives a reward or penalty to the polymer as it visits the origin. There is a critical value of u above which polymer is pinned, placing a positive fraction of its monomers at 0 with high probability. Our first result is the existence of quenched and annealed free energies at all potential level and temperature. To see the effect of disorder on the depinning transition, we compare the quenched free energy of

the system as a function of u to the corresponding annealed system. Our main result is that in $1+1$ dimensional case, the quenched and annealed critical curves differ significantly only in a very small neighborhood of the critical point and we show that the size of this neighborhood scales as β where β is the inverse temperature. (Received September 11, 2013)

62 ► Statistics

1095-62-12 **saman moradian jahoudbejari*** (saman_com69@yahoo.com), 4351846443 fouman, guilan, Iran. *framing effects in prince plays.* Preliminary report.

many previous experiments document that behavior in multi-person settings responds to the name of the game and the labeling of strategies. usually these studies cannot tell whether frames effect preferences or beliefs. in this prince play study, we investigate whether social framing effects are also present when only one of the subjects makes a decision, in which case the frame may only effect preferences. we find that behavior is insensitive to social framing. (Received May 13, 2013)

1095-62-31 **Michael Waterman***, msw@usc.edu. *Sequence Comparison Without Alignment.*

Traditionally the comparison of biological sequences has been based on the order of the letters in the sequences. A drawback of this class of methods is the running time of algorithms designed to discover significant similarity between the sequences. In this talk some simple statistics based of counts of k-letter words will be presented along with some of their unusual properties. (Received August 19, 2013)

1095-62-57 **Venkat Chandrasekaran*** (venkatc@caltech.edu) and **Michael Jordan**. *Computational and Statistical Tradeoffs via Convex Relaxation.*

Modern massive datasets create a fundamental problem at the intersection of the computational and statistical sciences: how to provide guarantees on the quality of statistical inference given bounds on computational resources such as time or space. Our approach to this problem is to define a notion of "algorithmic weakening," in which a hierarchy of algorithms is ordered by both computational efficiency and statistical efficiency, allowing the growing strength of the data at scale to be traded off against the need for sophisticated processing. We illustrate this approach in the setting of denoising problems, using convex relaxation as the core inferential tool. Hierarchies of convex relaxations have been widely used in theoretical computer science to yield tractable approximation algorithms to many computationally intractable tasks. In this talk we show how to endow such hierarchies with a statistical characterization and thereby obtain concrete tradeoffs relating algorithmic runtime to amount of data. (Received August 26, 2013)

1095-62-88 **Lester Mackey*** (lmackey@stanford.edu). *The Asymptotics of Ranking Algorithms.*

Consider the problem of supervised ranking, where the task is to rank sets of candidate items returned in response to queries. Although there exist supervised ranking procedures that come with guarantees of consistency, these procedures require that individuals provide a complete ranking of all items, which is rarely feasible in practice. Instead, individuals routinely provide partial preference information, such as pairwise comparisons of items, and more practical approaches to ranking have aimed at modeling these partial preferences directly. However, such approaches have serious theoretical shortcomings. We demonstrate that many commonly used surrogate losses for pairwise comparison data fail to yield consistency, even in low-noise settings. With these negative results as motivation, we present a new approach to supervised ranking based on aggregation of partial preferences and develop U-statistic-based empirical risk minimization procedures. We present an asymptotic analysis of these new procedures, showing that they yield consistency results that parallel those available for classification. We complement our theoretical results with an experiment studying the new procedures in a large-scale web-ranking task. Joint work with John Duchi and Michael Jordan. (Received August 31, 2013)

1095-62-117 **Yaming Yu*** (yamingy@uci.edu) and **Xiao-Li Meng**. *Accelerating MCMC by interweaving multiple parameterizations.*

Reparameterization is known to drastically improve the efficiency of some MCMC algorithms. Building on the idea of reparameterization, a variety of methods have evolved, including conditional augmentation, marginal augmentation, parameter-expanded data augmentation, partially non-centering parameterization, sandwiched algorithms, and interweaving strategies. Here we demonstrate that by interweaving two specific kinds of parameterizations, the sufficient and ancillary augmentations, we can gain considerable speed in convergence while maintaining simplicity in construction. We also discuss how the various methods can be viewed from the perspective of regression residuals, and how the orthogonality between regression functions and residuals helps reduce

the dependence among MCMC draws. We present both theoretical results and empirical illustrations involving simulations and real data. (Received September 04, 2013)

1095-62-205 **James M. Flegal***, 1428 Olmsted Hall, 900 University Ave, Riverside, CA 92521, and **Lei Gong**, 1337 Olmsted Hall, 900 University Ave, Riverside, CA 92521. *Relative fixed-width stopping rules for Markov chain Monte Carlo simulations.*

Markov chain Monte Carlo (MCMC) simulations are commonly employed for estimating features of a target distribution, particularly for Bayesian inference. A fundamental challenge is determining when these simulations should stop. We consider a sequential stopping rule that terminates the simulation when the width of a confidence interval is sufficiently small relative to the size of the target parameter. Specifically, we propose relative magnitude and relative standard deviation stopping rules in the context of MCMC. In each setting, we develop sufficient conditions for asymptotic validity, that is conditions to ensure the simulation will terminate with probability one and the resulting confidence intervals will have the proper coverage probability. Our results are applicable in a wide variety of MCMC estimation settings, such as expectation, quantile, or simultaneous multivariate estimation. Finally, we investigate the finite sample properties through a variety of examples and provide some recommendations to practitioners. (Received September 09, 2013)

1095-62-216 **X. Bresson**, **T. Laurent**, **D. Uminsky** and **J. von Brecht*** (jub@math.ucla.edu). *Multiclass Total Variation Clustering.*

Ideas from the image processing literature have recently motivated a new set of clustering algorithms that rely on the concept of total variation. While these algorithms perform well for bi-partitioning tasks, their recursive extensions yield unimpressive results for multiclass clustering tasks. We present a general framework for multiclass total variation clustering that does not rely on recursion. The results greatly outperform previous total variation algorithms and compare well with state-of-the-art NMF approaches. (Received September 09, 2013)

1095-62-283 **Dan Nordman*** (dnordman@iastate.edu). *Non-standard Blockwise Empirical Likelihood for Time Series*

Standard blockwise empirical likelihood (BEL) for stationary, weakly dependent time series involves data-blocking to capture dependence and requires specifying a fixed block length as a tuning parameter for setting confidence regions. This aspect can be difficult and impacts coverage accuracy. This talk presents an alternative version of BEL based on a data block of every length. Consequently, the method does not involve usual block selection issues and is also anticipated to exhibit better coverage performance. The non-standard blocking in the proposed approach, however, induces a non-standard asymptotic distribution for log-ratio statistics in calibrating confidence regions. This limit law is not the usual chi-square one, but is distribution-free and can be easily simulated. Numerical studies suggest that the modified BEL method generally exhibits better coverage accuracy than standard BEL. (Received September 27, 2013)

1095-62-284 **Alex Aue*** (aaue@ucdavis.edu). *On the prediction of functional time series*

This talk addresses the prediction of functional time series. Existing contributions to this problem have largely focused on the special case of first-order functional autoregressive processes because of their technical tractability and the current lack of advanced functional time series methodology. It is shown here how standard multivariate prediction techniques can be utilized in this context. The connection between functional and multivariate predictions is made precise for the important case of vector and functional autoregressions. The proposed method is easy to implement, making use of existing statistical software packages, and may therefore be attractive to a broader, possibly non-academic, audience. Its practical applicability is enhanced through the introduction of a novel functional final prediction error model selection criterion that allows for an automatic determination of the lag structure and the dimensionality of the model. The usefulness of the proposed methodology is demonstrated in a simulation study and an application to environmental data, namely the prediction of daily pollution curves describing the concentration of particulate matter in ambient air. It is found that the proposed prediction method often significantly outperforms existing methods. (Received September 27, 2013)

1095-62-285 **Hernando Ombao*** (hombao@uci.edu). *Modeling Cross-Oscillatory Interactions with Applications to Multivariate Brain Signals*

We shall discuss approaches to characterizing cross-oscillatory dependence between components of a multivariate time series (e.g., between brain regions). This work is motivated by a growing body of evidence that suggests various neurological disorders may be associated with altered brain connectivity. Cross-oscillatory dependence

may be portrayed in a number of ways, e.g., coherence and partial coherence. However, these describe cross-oscillations only at the same frequency band. Hence, they do not capture more complex dependence structures in brain signals. Using harmonizable processes, which was carefully studied by K-S Lii and M Rosenblatt, one can model oscillations between different frequency bands. There still remain important scientific questions that cannot be addressed with current statistical models. For example, scientists would like to test if oscillations at the theta band around the current time can predict gamma oscillations at a future time. As an initial step, we present an exploratory analysis using the vector-autoregressive model of the band-specific time-segmented periodograms. We conclude with potential time-evolutionary generalizations of harmonizable processes. (Received September 27, 2013)

1095-62-286 **Gabriel Chandler*** (Gabriel.Chandler@pomona.edu). *Order selection for Time Varying Autoregression*

The simple but versatile model in which the variance of an AR model is a function of time is considered. To select the order of the autoregression, the AIC or its variants are often considered, however, these require a global estimate of the noise, which lacks interpretability. We will see that the concentration of the variance function is the key player in our ability to select the correct order. A simple technique for handling this problem will be proposed. (Received September 27, 2013)

1095-62-287 **S. N. Lahiri*** (snlahiri@ncsu.edu). *On the accuracy of percentile-t block bootstrap confidence intervals*

In this talk, we focus on coverage accuracy of the percentile-t confidence intervals (CIs) for parameters under a smooth function model. We show that the optimal bandwidth of the Studentizing factor that reduces the coverage error of a normal CI can be very different from the MSE-optimal bandwidth.

We also investigate the effects of the block size on the coverage accuracy of percentile-t confidence intervals based on the moving block bootstrap. (Received September 27, 2013)

1095-62-288 **Dimitris N. Politis*** (dpolitis@ucsd.edu). *Estimation of a high-dimensional autocovariance matrix with applications*

Given data consisting of a stretch of size n from a stationary time series, the prime objective is consistent estimation of the n by n Toeplitz autocovariance matrix. Under short range dependence assumptions, convergence rates are established for a flat-top tapered version of the sample autocovariance matrix and its inverse. Two applications will be discussed: (a) a new method for time series resampling, the so-called Linear Process Bootstrap; and (b) one-step-ahead linear prediction using the complete data history. (Received September 27, 2013)

65 ► Numerical analysis

1095-65-142 **Youngjoon Hong***, 831 E. Third St., Bloomington, IN 47405, and **Arthur Bousqet**, **Gung-Min Gie** and **Jacques Laminie**. *High resolution finite volume method for inviscid primitive equations in a complex domain.*

In this talk, I will present the cell-centered Finite Volume discretization of the two-dimensional inviscid primitive equations in a complex domain. To compute the numerical fluxes, the so-called Central-upwind Finite Volume scheme (CUS) and High resolution central-upwind scheme (HRCUS) are introduced. Performing the numerical tests without using any mesh refinement near the topography, the CUS (or HRCUS) is a robust first (or second) order scheme, regardless of the shape or size of the topography. The methods can be made useful in other numerical studies of some models from conservation laws, in particular when the domain has a non-flat boundary. (Received September 06, 2013)

1095-65-233 **Rongjie Lai*** (rongjiel@math.uci.edu) and **hongkai Zhao**. *Solving PDEs on Point clouds and applications.*

In this talk, I will present two systematic methods to solve PDEs on manifolds represented as meshless point clouds. Global mesh structures or parameterizations are usually hard to construct in this case. While our methods only rely on the local structure at each data point and scale well with the total number of points and the intrinsic dimension of point clouds. Once the local structure is available, we propose numerical schemes to approximate differential operators and define integrals on point clouds, which can be used to solve partial differential equation (PDE) and variational problem on point clouds. The proposed framework can be easily adapted to solve PDEs on k-manifolds in R^n. Numerical comparisons with existing methods demonstrate the

accuracy of the proposed methods. Finally, several applications to geometric understanding of point clouds will be discussed based on solutions of PDEs on point clouds. (Received September 10, 2013)

1095-65-263 **Blake A Hunter*** (blakehunter@math.ucla.edu), 1141 W. 22nd St., Upland, CA 91784.
Spectral methods for analyzing large data.

There has been increasing demand to understand the data around us. The flood of social media requires new mathematics, methodologies and procedures to extract knowledge from massive datasets. Spectral methods are numerical linear algebra graph based techniques that uses eigenfunctions of a graph to extract the underlying global structure of a dataset. The construction of these, application dependent, graphs require new mathematical ideas that extend data representation, distance, topic modeling and sparsity. The product is often massive matrices that push the limits of matrix computation. This talk looks at applications to analyzing street gang networks, Twitter microblogs and content based search. (Received September 10, 2013)

68 ► Computer science

1095-68-67 **Ekaterina Merkurjev***, kmerkurjev@gmail.com, and **Andrea Bertozzi** and **Tijana Kostic**. *An MBO Scheme on Graphs for Classification and Image Processing.*

In this paper we present a computationally efficient algorithm utilizing a fully or semi nonlocal graph Laplacian for solving a wide range of learning problems in binary data classification and image processing. In their recent work "Diffuse Interface Models on Graphs for Classificaiton of High Dimensional Data", Bertozzi and Flenner introduced a graph-based diffuse interface model utilizing the Ginzburg-Landau functional for solving problems in data classification. Here, we propose an adaptation of the classic numerical Merriman-Bence-Osher (MBO) scheme for minimizing graph-based diffuse interface functionals, like those originally proposed in the paper by Bertozzi and Flenner. We also make use of fast numerical solvers for finding eigenvalues and eigenvectors of the graph Laplacian, needed for the inversion of the operator. Various computational examples are presented to demonstrate the performance of our algorithm, which is successful on images with texture and repetitive structure due to its nonlocal nature. The results show that our method is multiple times more efficient than other well known nonlocal models. (Received August 27, 2013)

1095-68-95 **Cristina Garcia-Cardona*** (cristina.cgarcia@gmail.com), 14245 Dickens St. (#108), Sherman Oaks, CA 91423. *Diffuse Interface Models for Semi-Supervised Learning on Graphs: Multiclass Generalizations of the Ginzburg-Landau Functional.*

We propose generalizations of a binary diffuse interface model for graph segmentation to the case of multiple classes. The original binary diffuse interface model adapts the Ginzburg-Landau (GL) continuum energy functional to a semi-supervised setup on graphs. The graph structure is used to encode a measure of similarity between data points. A small sample of labeled data points (semi-supervised) serves as seeds from which label information can be propagated throughout the graph structure. We develop two multiclass generalizations, one based on a scalar representation and other based on a vector-field representation. We compare the performance of the two multiclass formulations in synthetic data as well as real benchmark sets, and demonstrate that our experimental results are competitive with the state-of-the-art among other graph-based algorithms. (Received September 01, 2013)

1095-68-182 **Mihai Cucuringu*** (mcucurin@math.princeton.edu). *ASAP: an algorithm for the graph realization problem via eigenvector synchronization.*

In this talk we present ASAP, an algorithm for localization of sensors from noisy measurements of a subset of their Euclidean distances. ASAP is a divide and conquer, non-incremental algorithm which integrates local distance information into a global structure determination. The algorithm starts by finding, embedding and aligning uniquely realizable subsets of neighboring sensors called patches. In the noise-free case, each patch agrees with its global positioning up to an unknown rigid motion of translation, rotation and possibly reflection. Reflections and rotations are estimated using the recent developed eigenvector synchronization algorithm, while translations are estimated by solving an overdetermined linear system. Extensive numerical experiments on synthetic and real data sets from two-dimensional sensor networks and three-dimensional structural biology, show that it compares favorably to other existing algorithms in terms of robustness to noise, sparse connectivity and running time. Time permitting, we discuss and application of synchronization over Z_2 to bipartite multislice networks, where we apply the eigenvector and semidefinite programming synchronization methods to a data set of voting patterns in the U.S. Congress, to identify the Democratic and Republican parties. Joint work with

Yaron Lipman (Weizmann Institute of Science), Amit Singer (Princeton University) and David Cowburn (Albert Einstein College of Medicine of Yeshiva University). (Received September 08, 2013)

76 ► Fluid mechanics

1095-76-201 **James P Kelliher*** (kelliher@math.ucr.edu), Dept. of Mathematics, Surge 202, Riverside, CA 92506. *On the behavior of bounded vorticity, bounded velocity solutions to the 2D Euler equations.* Preliminary report.

I will present recent work characterizing all possible weak solutions to the 2D Euler equations in the full plane or the exterior of a single obstacle having bounded velocity and bounded vorticity. The class of all such solutions generalizes the solutions obtained originally by Phillipe Serfati in 1995 for the full plane, which have sublinear growth of the pressure at infinity. For more general solutions a condition at infinity, in terms of the velocity or the pressure, holds weakly, and the circulation about the obstacle can vary for an exterior domain (if the pressure is not required to be single-valued). These results build on those of joint work with Ambrose, Lopes Filho, and Nussenzveig Lopes. (Received September 09, 2013)

1095-76-268 **Animikh Biswas**, **Ciprian Foias** and **Adam Larios*** (alarios@math.tamu.edu), Dept. of Mathematics, MS 3368, TAMU, College Station, TX 77801. *The Asymptotic Behavior of Semi-Dissipative Systems.*

The asymptotic dynamics of dissipative systems has been studied for many years. Some of the ideas from this study can be carried over to the setting of certain equations which occur naturally in fluid dynamics, but which are only semi-dissipative. This gives rise to a structure in the phase space that is extremely rich in terms of the variety of solutions it contains, and which has many connections with the statistical theory of turbulence. We will discribe this structure and explore some of its connections with turbulence. (Received September 10, 2013)

81 ► Quantum theory

1095-81-3 **Matilde Marcolli*** (matilde@caltech.edu), Department of Mathematics, California Institute of Technology, 1200 E California Blvd, Pasadena, CA 91125. *Feynman integrals and motives.*

I will survey some recent approaches relating the computation of Feynman integrals in perturbative quantum field theory to periods and Grothendieck's theory of motives of algebraic varieties. (Received August 23, 2013)

1095-81-72 **Michael G Dombroski*** (dombroski@msn.com). *A Finite, Integer-based Origin of Fermion and Boson Symmetries.* Preliminary report.

Michael G Dombroski (dombroskiSTM11@verizon.net), Los Angeles City College A Finite, Integer-based Origin of Fermion and Boson Symmetries. In a previous paper, (1086-81-1848, Abstracts, Volume 34, Issue 171, Winter 2013), "STM Matrix Mechanics: The Origin of Electric Charge",was presented. This paper examines 3x3 matrices with Fermion and Boson Symmetries. They are introduced with one empirically-found, finite, completely real, integer algebra example. The derivations use symmetrical Transpose and Cispose operations. The (called here) Cispose, is the complement of Transpose. It is not widely used. The key element in this work is a finite, real, integer analog of Dirac bra-kets, (called here) bbra-kkets (◄)(►).© Here is a bb-kk example, a sum of product pairs: (anbn+cndn+en^2) =:(an+cn+en◄)(►bn+dn+en).The order of terms is important. At this level, addition is not commutative. For the Dirac bra-ket "The eigenvalues associated with eigenkets are the same as the eigenvalues of the eigenbras." [Dirac QM pg31] Analogously, here the products associated with the kkets are the same as the products of the bbras.

http://dombroskiSTM.org/com/net (Received August 28, 2013)

1095-81-266 **Michael Anthony Maroun*** (mmaro001@ucr.edu). *A New Method of Analysis for the Spectrum of the Sum of the Laplace Operator and a Finite Number of Derivatives of the Dirac Delta Distribution.*

A new method of analysis was developed to determine the spectrum of the operator given by the sum of the Laplace operator and a finite number of derivatives of the Dirac measure on $\mathbb{R}$. The method is extended to $\mathbb{R}^n$ and an alternative proof of the empty bound state spectrum for the sum of the Laplace operator and the Dirac delta measure when $n \geq 4$ is obtained. Previous proofs required either operator indices from functional analysis or non-standard analysis. The essence of the new method involves the smoothing of solutions of the operator

equation by convolution and subsequent extraction of local information to obtain the spectrum. (Received September 10, 2013)

92 ► Biology and other natural sciences

1095-92-69 **Pierre Baldi***, Dept. of Computer Science, UCI, Irvine, CA 92697. *Deep Learning: Theory, Algorithms, and Biological Applications.*

Learning is essential for building intelligent systems, whether carbon-based or silicon-based ones. Moreover these systems do not solve complex task in a single step but rather go through multiple processing stages. Hence the question of deep learning, how efficient learning can be implemented in deep architectures. This fundamental question not only impinges on problems of memory and intelligence in the brain, but it is also at the forefront of current machine learning research. In the last year alone, new performance breakthroughs have been achieved by deep learning methods in applications areas ranging from computer vision, to speech recognition, to natural language understanding, to bioinformatics. This talk will provide a brief overview of deep learning, from its biological origins to some of the latest theoretical, algorithmic, and application results. Particular emphasis will be given to the development of learning methods–in the form of recursive neural networks– for structured, variable-size, data, and their applications to the problems of predicting the properties of small molecules and the structure of proteins. (Received August 27, 2013)

1095-92-138 **Robert Sacker*** (rsacker@usc.edu), University of Southern California, Mathematics Department, KAP 104, Los Angeles, CA 90089-2532, and **Yi Yang**. *Periodic Unimodal Allee Maps, the Semigroup Property and the Discrete λ-Ricker Equation with Allee Effect.*

The discrete λ-Ricker equation has an attracting fixed point at the origin, an unstable fixed point, the Allee threshold and an attracting fixed point, the carrying capacity. Population densities initially below the Allee threshold are driven to the zero fixed point, i.e. extinction while population densities initially above are attracted to the carrying capacity. The k-periodic λ-Ricker equation is studied and parameter intervals are determined for which there exist a k-periodic Allee state and a k-periodic attracting state.

In the management of fisheries, in particular, it is important to know the acceptable level of harvesting in order to stay above the Allee threshold. Knowing the effect of seasonal variation on the Allee threshold is therefore important. (Received September 06, 2013)

93 ► Systems theory; control

1095-93-90 **Hubertus von Bremen*** (hfvonbremen@csupomona.edu), Cal Poly Pomona, 3801 West Temple Avenue, Department of Mathematics and Statistics, Pomona, CA 91768. *Some stability results in the time delayed control of structural systems using single and multiple actuators.*

In the active control of large-scale structures, it is inevitable to have time delays in the control. The actuator and sensor dynamics do not allow for the instantaneous generation of the large high frequency forces usually needed in the control. This introduces a delay in the control system. Here we present some stability results of time delayed control of systems with single actuators and we extend some of these results for systems with multiple actuators. (Received August 31, 2013)

1095-93-147 **Paul A Fuhrmann*** (fuhrmannbgu@gmail.com) and **Uwe Helmke**. *Open loop control for state systems.* Preliminary report.

Given a discrete-time, reachable linear system, in state space form $(zI - A)x(z) = Bu(z)$, initially at rest. Our aim is to compute controls that steer the system to a prescribed state ξ. The reachability map is defined by $\mathcal{R}_{(A,B)}u = \pi_{zI-A}Bu$ for $u(z) \in \mathbb{F}[z]^m$, which is a surjective $\mathbb{F}[z]$ homomorphism. We note that $\mathcal{R}_{(A,B)}$ has a kernel which is a full submodule, hence representable as $D\mathbb{F}[z]^m$ for a nonsingular $D(z)$. Factoring out the kernel, we get the reduced reachability map given by $\mathcal{R} = \mathcal{R}_{(A,B)}|X_D$. By construction $\mathcal{R}$ is an isomorphism and we invert it by embedding the intertwining relation $BD(z) = (zI - A)H(z)$ the following doubly coprime factorization

$$\begin{pmatrix} Y(z) & X(z) \\ -B & zI - A \end{pmatrix} \begin{pmatrix} D(z) & -X'(z) \\ H(z) & Y'(z) \end{pmatrix} = \begin{pmatrix} I & 0 \\ 0 & I \end{pmatrix}.$$

In this case we have $u_m(z) = \mathcal{R}^{-1}\xi = \pi_D X'\xi$.

Extensions to some standard networks of linear systems will be indicated.

Key words: Linear systems, controllability, open loop control, unimodular embedding.
(Received September 07, 2013)

97 ► Mathematics education

1095-97-14 **Afrah Ahmad Abdou*** (aabdou@kau.edu.sa), PO Box 8020, Jeddah , Saudi Arabia, Jedda, Saudi Arabia, and **Mohamed Amin Khamsi** (mohamed@math.utep.edu), 7049 westwind, El paso, TX 79912. *Fixed Point Results of pointwise Contraction in Modular Metric Spaces.* Preliminary report.

The notion of a modular metric on an arbitrary set and the corresponding modular spaces, generalizing classical modulars over linear spaces like Orlicz spaces, were recently introduced. In this paper we investigate the existence of fixed points of modular contractive mappings in modular metric spaces. These are related to the successive approximations of fixed points (via orbits) which converge to the fixed points in the modular sense, which is weaker than the metric convergence. (Received June 04, 2013)

1095-97-274 **Blerta Shtylla***, Mathematics Department, Claremont, CA 91711. *An interdisciplinary group approach to teaching Differential Equations: Experiences and challenges.*

In this talk, I will discuss the incorporation of online tools and short group projects in an introductory Differential Equations Course with modeling. The students enrolled in this course come from a variety of disciplines, such as natural sciences, economics, and social sciences, so the incorporation of a variety of modeling examples and short projects has been a necessary component for teaching. I will discuss my implementation of group projects, the establishment of student working groups and the joys and challenges of incorporating computational software in the class. Furthermore, a series of examples of online lesson building and class wikis will be shown. (Received September 10, 2013)

1095-97-279 **Angela Gallegos*** (agalle11@lmu.edu), CA , and **Zhengyi Zhou Meercamp** (zz254@cornell.edu), Center for Applied Mathematics, Cornell University, Ithaca, NY. *Road Rage and You: Macroscopic traffic models as a means to teaching ordinary and delay differential equations.* Preliminary report.

We use ordinary and delay differential equations (ODEs and DDEs respectively) to "macroscopically" model traffic flow in a single lane or link that has traffic lights. The ODE model in particular provides students with an accessible framework to explore a model type usually reserved for partial differential equations. In addition, the model is an excellent opportunity to explore stability properties and numerical simulation within this modeling framework. However, the comparative framework with the DDE setting allows an introduction to a type of differential equation not usually seen at the undergraduate level. In particular, this opens the door to comparisons of different modeling approaches and the implications of different choices in method. (Received September 11, 2013)

2010 MATHEMATICS SUBJECT CLASSIFICATION

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