ABSTRACTS

of Papers Presented to the American Mathematical Society

Volume 33, Number 4, Issue 170 Fall 2012

Abstracts for

ISSN 0192-5857 Pages 929–1050

AMS

SUBMISSION INFORMATION

ABSTRACTS PUBLISHED IN THIS JOURNAL are those submitted by authors who intend to present them at AMS meetings (see the front cover). The abstracts for each meeting are sorted by the two-digit 2010 Mathematics Subject Classification chosen by the author and appear in the order received. See the back cover for the 2010 Mathematics Subject Classification.

THE SUITABILITY OF A PAPER for presentation to the Society is judged from the abstract as outlined in Article X, Section 6 of the bylaws:

> Papers intended for presentation at any meeting of the Society shall be passed upon in advance by a program committee appointed by or under the authority of the Council; and only such papers shall be presented as shall have been approved by such committee. Papers in a form unsuitable for publication, if accepted for presentation, shall be referred to on the program as preliminary communications or reports.

In addition, the editors of the *Abstracts* have adopted the following policy: In order to be accepted for publication, an abstract must have mathematical research content. It should not contain libelous, defamatory, or tasteless remarks, commercial promotions, nor political or religious arguments. Papers may not be presented if published in full before the date of the Society meeting or if previously presented to any learned Society except the National Academy of Sciences or the Royal Society of Canada. The AMS assumes no responsibility for the content or inappropriate remarks in any published abstract.

GENERAL INFORMATION ON ABSTRACTS is found at `http://www.ams.org/abstracts`.

ABSTRACTS ARE PRINTED from copy submitted by the author. Web submission is the required electronic format. To access the interactive template, visit the Abstracts submission page on the AMS website at `http://www.ams.org/cgi-bin/abstracts/abstract.pl`. Step-by-step submission instructions are included in the template. No knowledge of LaTeX is necessary; however, any mathematical displays or accent marks in text or in names must be coded in LaTeX. Requests for general information concerning abstracts may be sent to `abs-coord@ams.org`.

THE ABSTRACT RECEIPT DEADLINES FOR ALL MEETINGS will be strictly enforced. Unfortunately, late papers cannot be accommodated. When all talks have been scheduled for a given meeting, the attendant abstracts will be available for viewing on the AMS website through the program display for that meeting.

NOTATIONS IN THIS JOURNAL are the following:

* Indicates who will present the paper at the meeting.

SUBSCRIPTION INFORMATION

CHANGES OF ADDRESS should be reported six weeks in advance to avoid disruption of service. Changes of address and all general correspondence should be sent to Member and Customer Services, American Mathematical Society, 201 Charles Street, Providence, RI 02904-2294 USA (email: amsmem@ams.org or fax: 401-455-4026); dues payments and orders for AMS publications should be addressed to the Society at P.O. Box 845904, Boston, MA 02284-5904 USA; all correspondence relating to advance registration for meetings should be addressed to the Society, 201 Charles Street, Providence, RI 02904-2294 USA.

Abstracts of Papers Presented to the American Mathematical Society (ISSN 0192-5857) is published four times a year by the American Mathematical Society at 201 Charles Street, Providence, RI 02904-2294. The subscription price for Volume 33 (2012) is US$156 list, US$124.80 institutional member, US$93.60 individual member. Subscription renewals are subject to late fees. See `www.ams.org/customers/macs-faq.html#journal` for more information. Periodicals postage paid at Providence, RI. Add for postage: Surface delivery to destinations outside the U.S.—US$11, to India—US$18. Expedited delivery to destinations in North America—US$14, elsewhere—US$41. POSTMASTER: Send address change notices to Abstracts of Papers Presented to the American Mathematical Society, 201 Charles Street, Providence, RI 02904-2294 USA.

10 9 8 7 6 5 4 3 2 1 16 15 14 13 12

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
1086	January 9–12, 2013	San Diego, CA	September 25	Vol 34, No. 1
1087	March 1–3, 2013	Oxford, MS	December 4	Vol 34, No. 2
1088	April 6–7, 2013	Chestnut Hill, MA	February 12	Vol 34, No. 2
1089	April 13–14, 2013	Boulder, CO	February 19	Vol 34, No. 2
1090	April 27–28, 2013	Ames, IA	March 5	Vol 34, No. 2
1091	June 27–30, 2013	Alba Iulia, Romania	TBA	None
1092	October 5–6, 2013	Louisville, KY	August 13	Vol 33, No. 3
1093	October 12–13, 2013	Philadelphia, PA	August 20	Vol 33, No. 3
1094	October 18–20, 2013	St. Louis, MO	August 27	Vol 33, No. 4
1095	November 2–3, 2013	Riverside, CA	September 10	Vol 33, No. 4
1096	January 15–18, 2014	Baltimore, MD	TBA	Vol 35, No. 1

AKRON, OH, October 20–21, 2012

Abstracts of the 1084th Meeting.

00 ► General

1084-00-157 **Mikhail Belkin***, Computer Science and Engineering, 2015 Neil Ave, DL 395, Columbus, OH 43210, and **Qichao Que**, **Yusu Wang** and **Xueyuan Zhou**. *Toward understanding complex spaces: graph Laplacians on manifolds with singularities and boundaries.*

Algorithms based on graph Laplacian have received considerable attention both in practical applications and theoretical analysis. Much of the existing work has been done under the assumption that the data is sampled from a manifold without boundaries. However, singularities and boundaries are an important aspect of the geometry of realistic data. Boundaries occur whenever the data has a constraint; while singularities appear when two different manifolds intersect or if a process undergoes a "phase transition", changing non-smoothly as a function of a parameter. We consider the behavior of graph Laplacians at points at or near boundaries and two main types of singularities: intersections, wheremanifolds come together and sharp "edges". We show that the behavior of graph Laplacian near these singularities is different from that in the interior of the manifolds. Unlike in the interior of the domain, where graph Laplacian converges to the Laplace-Beltrami operator, near singularities graph Laplacian tends to a first-order differential operator, with different scaling behavior. One implication is that while points near the singularities occupy only a small part of the total volume, the difference in scaling results in a large contribution to the total behavior. (Received August 30, 2012)

01 ► History and biography

1084-01-102 **Michael Todd Edwards*** (m.todd.edwards@gmail.com), Department of Teacher Education, 401 McGuffey Hall, Oxford, OH 45056. *Of GeoGebra and iPads: Using iBook Author as a Tool to Implement Common Core Mathematics.* Preliminary report.

More than ever, mathematics teachers live in a world marked by uncertainty and rapid change. Ohio's recent adoption of Common Core State Standards for Mathematics (CCSSM) represents a significant challenge (and opportunity) for classroom teachers, students, and curriculum developers. In this interactive, hands-on session, we discuss the use of GeoGebra Dynamic Mathematics Software and iBook Author software in the creation of interactive teaching materials aligned to CCSSM. Specifically, we share techniques for publishing interactive

teaching and learning materials that allow teachers and students to explore mathematical ideas with interactive sketches and video designed specifically for iPad tablet computers. (Received August 26, 2012)

05 ► Combinatorics

1084-05-10 **Andrzej Dudek***, Department of Mathematics, Western Michigan University, Kalamazoo, MI 49008. *On restricted Ramsey numbers.*

A classical Ramsey theorem states that in any 2-coloring of the edges of a sufficiently large complete graph, one will always find a monochromatic complete subgraph. In 1970, Folkman extended this result showing that for any graph G there exists a graph H with the same clique number as G such that any 2-coloring of the edges of H yields a monochromatic copy of G.

In this talk, we present some old and recent developments concerning Folkman-type results for vertex colorings of graphs and hypergraphs. (Received June 23, 2012)

1084-05-13 **Linyuan Lu** (lu@math.sc.edu), **Austin Mohr*** (mohrat@email.sc.edu) and **László Székely** (szekely@math.sc.edu). *Quest for Negative Dependency Graphs.*

The Lovász Local Lemma is a well-known probabilistic technique commonly used to prove the existence of rare combinatorial objects. Its great success led to the development of the lopsided (or negative dependency graph) version of the lemma by Erdős and Spencer. In order to apply the lopsided lemma, the events of interest must be negative dependent, which is easier to satisfy but harder to identify than the independence required by the original version. After familiarizing ourselves with the lopsided lemma, we will explore several settings involving disparate combinatorial objects in which proper negative dependency graphs have been discovered. (Received June 27, 2012)

1084-05-16 **Craig M. Timmons*** (ctimmons@ucsd.edu), UC San Diego, 9500 Gilman Dr., La Jolla, CA 92093. *Bounds for B_k^+-sets.*

A set $A \subset \mathbb{Z}$ is a *B_k^+-set* if

$$a_1 + \cdots + a_k = b_1 + \cdots + b_k \text{ with } a_1, \ldots, a_k, b_1, \ldots, b_k \in A \tag{1}$$

implies $a_i = b_j$ for some $1 \le i, j \le k$. A is a *B_k-set* if (1) implies $(a_1, \ldots, a_k)$ is a permutation of $(b_1, \ldots, b_k)$. The problem of determining the largest B_k-set $A \subset [N]$ has been studied extensively. In this talk we will discuss the corresponding problem for B_k^+-sets. For odd $k \ge 3$, we use a Bose-Chowla B_k-set to construct a B_k^+-set $A \subset [N]$ with $|A| = 2^{1-1/k}N^{1/k} - o(N^{1/k})$. We use a combinatorial argument to prove non-trivial upper bounds on B_3^+-sets and B_4^+-sets. (Received August 23, 2012)

1084-05-18 **Alexandr Kostochka** and **Matthew Yancey*** (yancey1@illinois.edu). *Color-critical graphs with few edges.*

A graph G is *k-critical* if it has chromatic number k, but every proper subgraph of G is $(k-1)$–colorable. Let $f_k(n)$ denote the minimum number of edges in an n-vertex k-critical graph. We give a bound on $f_k(n)$ that is exact for every $n = 1 \pmod{k-1}$. It is also exact for $k = 4$ and every $n \ge 6$. The result improves the classical bounds by Gallai and Dirac and subsequent bounds by Krivelevich and Kostochka and Stiebitz. It establishes the asymptotics of $f_k(n)$ for every fixed k. We also present some applications of the result, in particular, a simple proof of the Grötzsch Theorem that every triangle-free planar graph is 3-colorable. (Received July 09, 2012)

1084-05-32 **Xiaofeng Gu*** (xgu@math.wvu.edu), Department of Mathematics, West Virginia University, Morgantown, WV 26506. *Characterizations of strength extremal graphs.*

With graphs considered as natural models for many network design problems, edge connectivity $\kappa'(G)$ and maximum number of edge-disjoint spanning trees $\tau(G)$ of a graph G have been used as measures for reliability and strength in communication networks modeled as graph G. Mader and Matula introduced the maximum subgraph edge connectivity $\overline{\kappa'}(G) = \max\{\kappa'(H) : H \text{ is a subgraph of } G\}$, and also considered $\overline{\kappa'}(G)$ reflecting the strength of the graph G. Motivated by their many useful applications in network design and by the established inequalities

$$\overline{\kappa'}(G) \ge \kappa'(G) \ge \tau(G),$$

we in this paper present the following:

(i) For each integer $k > 0$, a characterization for graphs G with the property that $\overline{\kappa'}(G) \le k$ but for any additional edge e not in G, $\overline{\kappa'}(G + e) \ge k + 1$.

(ii) For any integer $n > 0$, a characterization for graphs G with $|V(G)| = n$ such that $\kappa'(G) = \tau(G)$ with $|E(G)|$ minimized. (Received August 08, 2012)

1084-05-33 **Lucas Kramer** and **Ryan R. Martin*** (rymartin@iastate.edu), 396 Carver Hall, Department of Mathematics, Iowa State University, Ames, IA 50011, and **Michael Young**. *Diamond-free families in the Boolean lattice.*

For a family of subsets of $\{1,\dots,n\}$, ordered by inclusion, and a partially-ordered set P, we say that the family is P-free if it does not contain a subposet isomorphic to P. We want to compute $\mathrm{ex}(n,P)$, the largest size of a P-free family of subsets of $\{1,\dots,n\}$. It is conjectured that, for any fixed P, this quantity is $(k+o(1))\binom{n}{\lfloor n/2\rfloor}$ for some fixed integer k, depending only on P. The conjecture has been verified by Bukh in the case where P has a "tree shape". There are some other small posets P for which the conjecture has been verified. The smallest poset for which it is unknown is Q_2, the Boolean lattice on two elements. We will discuss improved bounds on the size of a Q_2-free family, utilizing Razborov's flag algebra method. (Received August 09, 2012)

1084-05-51 **George E Andrews*** (gea1@psu.edu), 306 McAllister Bldg., Mathematics Department, Pennsylvania State University, University Park, PA 16802. *From the Shanks acceleration method to partitions.*

In 1955, D. Shanks published a paper entitled, Nonlinear transformations of divergent and slowly convergent sequences. His object was to accelerate convergence. Surprisingly this method yielded several explicit identities relevant to classical q-series identities including a new proof of Euler's pentagonal number theorem. Recently M. Merca and I (J. Comb. Th., Ser. A, 119(2012),1639-1643) found a surprising relationship between Shanks's work and partition-theoretic interpretations of truncations of Euler's recurrence for p(n). A historical account of this study will be given along with open problems. (Received August 14, 2012)

1084-05-76 **Benjamin J Braun*** (benjamin.braun@uky.edu), 715 Patterson Office Tower, Department of Mathematics, University of Kentucky, Lexington, KY 40506. *s-Lecture Hall Partitions, Self-Reciprocal Polynomials, and Gorenstein Algebras.* Preliminary report.

In 1997, Bousquet-Melou and Eriksson initiated the study of lecture hall partitions, a fascinating family of partitions that yield a finite version of Euler's celebrated odd/distinct theorem. In subsequent work on s-lecture hall partitions, they considered the self-reciprocal property for various associated generating functions. We continue this line of investigation, connecting their work to the more general context of Gorenstein semigroup algebras. We focus on the Gorenstein condition for s-lecture hall cones when s is a sequence generated by a two-term recurrence with initial values 0 and 1.

This is joint work with Matthias Beck, Matthias Koeppe, Carla Savage, and Zafeirakis Zafeirakopoulos. (Received August 22, 2012)

1084-05-113 **Ronald J. Gould*** (rg@mathcs.emory.edu), Department of Math and CS, Emory University, Atlanta, GA 30322, **Paul Horn** (phorn@math.harvard.edu), Dept. Math, Harvard University, Cambridge, MA 02138, and **Colton Magnant** (dr.colton.magnant@gmail.edu), Dept. Math, Georgia Southern University, Statesboro, GA 30458. *On Multiply Chorded Cycles.*

A complete graph on k vertices has $f(k)=(k-1)(k+2)/2$ chords within any spanning cycle. Here we investigate minimum degree conditions that guarantee the existence of many vertex disjoint $f(k)$ chorded cycles in a graph. We show that if the order n is sufficiently large and the graph has minimum degree at least sk, then the graph contains s vertex disjoint cycles, each with at least $f(k)$ chords. This is, in a sense, a step towards a sparse Hajnal-Szmerédi theorem, where cliques are replaced by $f(k)$ chorded cycles. (Received August 27, 2012)

1084-05-118 **Ye Chen** (chenye@math.wvu.edu), Department of Mathematics, West Virginia University, Morgantown, WV 26505, **Hong-Jian Lai*** (hjlai@math.wvu.edu), Department of Mathematics, West Virginia University, Morgantown, 26525, **Keke Wang** (wangkk@math.wvu.edu), Department of Mathematics, West Virginia University, Morgantown, WV 26525, and **Meng Zhang** (mzhanggz@gmail.com), Department of Mathematics, West Virginia University, Morgantown, WV 26506. *Hamiltonian Properties in 3-connected Claw-free Graphs.*

For an integer $s_1,s_2,s_3>0$, let N_{s_1,s_2,s_3} denote the graph obtained by identifying each vertex of a K_3 with an end vertex of three disjoint paths P_{s_1+1}, P_{s_2+1}, P_{s_3+1} of length s_1,s_2, and s_3, respectively. It is known that every 3-connected $(K_{1,3},N_{8,0,0})$-free graph is hamiltonian. We prove the following results.

(i) Every 3-connected $(K_{1,3},N_{s_1,s_2,s_3})$-free graph with $s_1+s_2+s_3\le 9$ is hamiltonian.

(ii) Every 3-connected $(K_{1,3},N_{s_1,s_2,0})$-free graph with $s_1+s_2\le 8$ is hamiltonian. (Received August 27, 2012)

1084-05-135 **Chun-Hung Liu** and **Gexin Yu*** (gyu@wm.edu), College of William and Mary, Williamsburg, VA 23188. *Linear colorings of subcubic graphs.* Preliminary report.

A linear coloring of a graph is a proper coloring of the vertices of the graph so that each pair of color classes induces a union of disjoint paths. In this paper, we prove that every graph with maximum degree at most three has linear list chromatic number at most four so that the neighbors of every degree two vertex receive different colors, unless the graph is C_5 or $K_{3,3}$. This confirms a conjecture raised by Esperet, Montassier, and Raspaud. Our proof is constructive and yields a linear-time algorithm to find such a coloring. (Received August 28, 2012)

1084-05-142 **James Carraher*** (s-jcarrah1@math.unl.edu), **Michael Ferrara**, **Timothy Morris** and **Michael Santana**. *Pairs of forbidden subgraphs for pancyclicity.*

A graph G is pancylic if G contains cycles of all lengths from 3 to $|V(G)|$. We investigate which pairs of forbidden subgraphs imply that a 4-connected graph is pancylic. Let $N(i,j,k)$ be the graph formed by adding paths of lengths i, j, and k, to different vertices of a triangle. We show that if G is 4-connected, claw-free, and $N(i,j,k)$-free with $i+j+k=6$ and $i,j,k \neq 0$, then G is pancyclic. This is best possible and extends a result of Gould, Łuczak, and Pfender. (Received August 29, 2012)

1084-05-150 **Chinh T Hoang**, **Marcin Kaminski**, **Joe Sawada** and **R. Sritharan***, Computer Science Department, The University of Dayton, Dayton, OH 45469. *Finding and listing induced paths and cycles.*

Many recognition problems for special classes of graphs can be reduced to finding and listing induced paths and cycles in a graph. We design algorithms to list all induced paths and cycles of a given length in a graph. As applications of our findings, we give algorithms to recognize quasi-triangulated graphs and brittle graphs. Our algorithms' time bounds are incomparable with previously known algorithms. (Received August 29, 2012)

1084-05-161 **Michael Ferrara**, **Ellen Gethner**, **Stephen G Hartke**, **Derrick Stolee*** (stolee@illinois.edu) and **Paul S Wenger**. *Distinguishing Extension Number.* Preliminary report.

A k-coloring of a symmetric object is *distinguishing* if no non-trivial, color-preserving automorphism exists. We introduce the *distinguishing extension number* to be the minimum number m such that for all sets of m elements and all k-colorings of the other elements can extend to a distinguishing coloring of the object. Using a common proof structure, we study this parameter for the cycle graph, the unit circle, and the real line. (Received August 30, 2012)

1084-05-190 **James Carraher**, University of Nebraska-Lincoln, and **Stephen G. Hartke*** (hartke@math.unl.edu), University of Nebraska-Lincoln. *Eulerian circuits with no monochromatic transitions.*

Let G be an eulerian directed graph with a fixed edge coloring (not necessarily proper). A compatible circuit T is an eulerian circuit of G such that no consecutive edges in the circuit have the same color. We characterize the existence of a compatible circuit when G has no vertices of outdegree 3, strengthening results of Fleischner and Isaak. We also discuss the complications that arise when vertices of outdegree 3 are present. (Received August 31, 2012)

1084-05-192 **Jessica McDonald*** (mcdonald@auburn.edu). *Packing Steiner Trees.*

A classic theorem due to Nash-Williams and Tutte implies that a graph G contains k pairwise edge-disjoint spanning trees provided it is 2k-edge-connected. Kriesell has conjectured a generalization of this result for Steiner trees. Given a set of T distinguished vertices in a graph G, a T-Steiner tree is a subgraph of G that is a tree and that spans T. Kriesell's Conjecture is that a connected graph G should contain k edge-disjoint T-Steiner trees provided that every edge-cut of G that separates T has size at least 2k. In this talk we show that Kriesell's Conjecture holds when 2k is replaced by 5k+4.

Joint work with Matt DeVos and Irene Pivotto. (Received August 31, 2012)

1084-05-208 **Zoltan Furedi**, University of Illinois, Urbana, IL 61801, and **Tao Jiang*** (jiangt@muohio.edu), Miami University, Oxford, OH 45056. *Hypergraph Turan numbers of loose cycles and linear cycles.*

Given a positive integer n and a family $\mathcal{H}$ of r-graphs, the Turán number $ex_r(n,\mathcal{H})$ is the maximum number of edges in an r-graph on n vertices not containing any member of $\mathcal{H}$. An r-uniform loose cycle of length k consists of a cyclic list of r-sets $A_1,\dots,A_k$ such that $A_i \cap A_j \neq \emptyset$ if and only if $i=j$ or i,j are consecutive modulo k. A loose cycle is linear if consecutive sets in the list intersect in precisely one element. Let $\mathcal{C}_k^r$ denote the family of r-uniform loose cycles of length k and let L_k^r denote the r-uniform linear cycle of length k. For fixed $r,k \geq 3$,

Mubayi and Verstraete conjectured that $ex_r(n, \mathcal{C}_k^r) = \ell\binom{n-1}{r-1} + O(n^{r-2})$, where $\ell = \lfloor \frac{k-1}{2} \rfloor$. They proved the conjecture for all r when $k = 3$ or 4.

We prove their conjecture for all $r \geq 4, k \geq 3$ in a stronger form, namely, for all sufficiently large n, we will determine the exact value of $ex_r(n, \mathcal{C}_k^r)$ and characterize the unique extremal construction and establish stability. For $r \geq 5$, we also obtain exact results for linear cycles (which are harder to force than loose cycles). Our main tool is the delta system method. (Received September 02, 2012)

1084-05-239 **Nathan Kahl***, Seton Hall University, Dept. of Mathematics and Computer Science, 400 S. Orange Ave., South Orange, NJ 07079, and **Douglas Bauer**, **Edward Schmeichel** and **Michael Yatauro**. *Toughness and Binding Number.*

Let $\tau(G)$ and $\text{bind}(G)$ be the toughness and binding number, respectively, of a graph G. In the paper introducing binding number Woodall determined that $\tau(G) \geq \text{bind}(G) - 1$, noting that this was not best possible. In this paper we obtain best possible improvements of this inequality. (Received September 03, 2012)

1084-05-243 **Michael Ferrara**, **Timothy D. LeSaulnier**, **Casey Moffatt** and **Paul S. Wenger*** (pswsma@rit.edu). *The Asymptotics of the Potential Function.*

A sequence π of non-negative integers is *graphic* if there is a simple graph G whose degree sequence is π; in this case, G is a *realization* of π. Given a graph H, the sequence π is *potentially H-graphic* if there is a realization of π that contains H as a subgraph.

In 1991, Erdős, Jacobson, and Lehel defined the *potential number of H*, denoted $\sigma(H, n)$, to be the minimum integer such that every n-term graphic sequence with sum $\sigma(H, n)$ is potentially H-graphic. Since the sum of the terms of π is twice the number of edges in a realization of π, determining the potential number can be thought of as a potential version of the classical Turán problem. The potential number has been determined for various classes of graphs, including cliques, cycles, and complete bipartite graphs, but relatively little has been known about the potential numbers of arbitrary graphs. Here we determine the potential number asymptotically for all H, providing an Erdős-Stone-Simonovits-type theorem for the Erdős-Jacobson-Lehel problem. (Received September 03, 2012)

1084-05-252 **Jeff Cooper*** (jcoope8@uic.edu) and **Dhruv Mubayi** (mubayi@math.uic.edu). *Coloring triangle-free triple systems.*

A hypergraph is linear if any two edges share at most one vertex. Frieze and Mubayi showed that if a 3-uniform hypergraph is linear and triangle-free, then it can be properly colored with $O(\sqrt{\Delta}/\sqrt{\log \Delta})$ colors, where Δ is the maximum degree of the hypergraph. They later removed the triangle-free assumption, showing that the same bound holds for linear 3-uniform hypergraphs. Our work loosens the linear assumption. We show that any triangle-free 3-uniform hypergraph can be properly colored with $O(\sqrt{\Delta}/\sqrt{\log \Delta})$ colors. (Received September 03, 2012)

1084-05-258 **Jacob A Siehler*** (jsiehler@gmail.com). *Tiling Hamiltonian Cycles on the 24-Cell.*

We show how the quaternion structure of the 24-cell can be used to construct a solution to the recreational problem of tiling the edges of this polytope with congruent copies of a single Hamiltonian cycle. (Received September 03, 2012)

1084-05-259 **Jacob Anthony White***, 2606 Westwood Main Drive, Bryan, TX 77807. *Graph operads and associahedra.* Preliminary report.

We investigate the notion of operad in the category of graphical species. Moreover, we show how graph associahedra, and graph zonotopes give rise to operads, and monoids in graphical species. (Received September 03, 2012)

1084-05-262 **Louis DeBiasio*** (debiasld@muohio.edu) and **Theo Molla**. *Semi-degree threshold for anti-directed Hamilton cycles.* Preliminary report.

The *semi-degree* of a directed graph D, denoted $\delta^0(D)$, is the minimum of the minimum in-degree and the minimum out-degree. An *anti-directed Hamilton cycle* of D is a Hamilton cycle (in the underlying undirected graph) such that no pair of consecutive arcs form a directed path in D (note that the number of vertices of D must be even for such a cycle to exist).

In 1980, Grant conjectured that if D is a directed graph on $2n$ vertices with $\delta^0(D) \geq n$, then D contains an anti-directed Hamilton cycle. However, Cai gave a counterexample to Grant's conjecture by exhibiting a directed graph on $2n$ vertices with $\delta^0(G) = n$ having no anti-directed Hamilton cycle. We show that for sufficiently large n, if D is a directed graph on $2n$ vertices with $\delta^0(D) \geq n + 1$, then D contains an anti-directed Hamilton cycle.

This is joint work with Theo Molla. (Received September 03, 2012)

1084-05-265 **Stephane Durocher** and **Ellen Gethner*** (ellen.gethner@ucdenver.edu), Department of Computer Science, University of Colorado Denver, Denver, CO 80217, and **Debajyoti Mondal**. *New Results on the Geometric Thickness of Graphs.* Preliminary report.

A graph G is said to have *geometric thickness* t if there exists a straight line drawing of G with the edges partitioned into t sets such that each set of edges induces a plane graph and t is smallest possible. This definition is similar to the classical notion of thickness with two added restrictions, namely that the vertices in each plane layer are in the same location and the edges are line segments. We will discuss a variety of new results as well as open questions related to edge bound, chromatic number, and, if time permits, recognition problems. (Received September 03, 2012)

1084-05-276 **Marcelo Aguiar***, Texas A&M University, Department of Mathematics, College Station, TX 77843, and **Federico Ardila** and **Swapneel Mahajan**. *The antipode problem for Hopf monoids.*

A Hopf monoid (in Joyal's category of species) is an algebraic structure akin to that of a Hopf algebra. Combinatorial structures which compose and decompose give rise to Hopf monoids. The antipode of a Hopf monoid encodes information of combinatorial interest. We will discuss the antipode problem and solve it for some concrete Hopf monoids, including those of simple graphs and of generalized permutahedra. This is joint work with Federico Ardila and Swapneel Mahajan. (Received September 03, 2012)

1084-05-280 **Jennifer Diemunsch*** (jennifer.diemunsch@ucdenver.edu), **Michael Ferrara**, **Allan Lo**, **Casey Moffatt**, **Florian Pfender** and **Paul S. Wenger**. *Rainbow matchings in properly edge-colored graphs.*

In an edge-colored graph, a rainbow matching is a set of independent edges where each edge has a distinct color. In 2011, Wang asked if there is a function $f(\delta)$ such that a properly edge-colored graph G with minimum degree δ and order at least $f(\delta)$ must have a rainbow matching of size δ. Extremal approaches have been used by Lo and Tan as well as Sárközy and Gyárfás to positively answer this question, showing that $f(\delta) \leq 4\delta(G) - 3$. This talk discusses an $O(\delta(G)|V(G)|^2)$-time algorithm generating a rainbow matching in a properly edge-colored graph of order at least $13\delta/2$. This algorithm is particularly interesting in light of results from Le and Pfender, which discuss the complexity of determining the size of the largest rainbow matching in an edge-colored graph. (Received September 03, 2012)

1084-05-289 **Linyuan Lu** and **Kevin G Milans*** (milans@math.wvu.edu). *Forbidden Induced Posets in the Boolean Lattice.* Preliminary report.

The Turán problem is at the core of extremal graph theory; we study an analogue for partially ordered sets, or posets. The induced Turán number $\mathrm{La}^*(n, P)$ is the maximum size of a family of elements in the n-dimensional Boolean lattice that does not contain P as *an induced* subposet. Boehnlein and Jiang obtained the asymptotics of $\mathrm{La}^*(n, P)$ when the Hasse diagram of P is a tree. Not much is known about $\mathrm{La}^*(n, P)$ when the Hasse diagram of P contains cycles. We present bounds on $\mathrm{La}^*(n, P)$ when P is a series-parallel poset or the standard example. This is joint work with Linyuan Lu. (Received September 04, 2012)

1084-05-291 **Saúl A. Blanco*** (sblancor@depaul.edu), Department of Mathematical Sciences, DePaul University, Chicago, IL 60614, and **T. Kyle Petersen**, Department of Mathematical Sciences, DePaul University, Chicago, IL 60614. *Counting Dyck paths by area and rank.*

The set of Dyck paths of length $2n$ inherits a lattice structure from a bijection with the set of noncrossing partitions with the usual partial order. In this paper, we study the joint distribution of two statistics for Dyck paths: *area* (the area under the path) and *rank* (the rank in the lattice).

While area for Dyck paths has been studied, pairing it with this rank function seems new, and we get an interesting (q, t)-refinement of the Catalan numbers. We present two decompositions of the corresponding generating function: one refines an identity of Carlitz and Riordan; the other refines the notion of γ-nonnegativity, and is based on a decomposition of the lattice of noncrossing partitions due to Simion and Ullman.

Further, we show, via Biane's correspondence, that the joint distribution of area and rank for Dyck paths equals the joint distribution of length and reflection length for the permutations lying below the n-cycle $(12\cdots n)$ in the absolute order on the symmetric group. (Received September 04, 2012)

1084-05-296 **Shirley Elizabeth Law*** (selaw@ncsu.edu). *The Hopf Algebra of Sashes.*

A general lattice theoretic construction of Reading constructs Hopf subalgebras of the Malvenuto-Reutenauer Hopf algebra (MR) of permutations. The products and coproducts in these Hopf subalgebras are defined extrinsically in terms of the embedding in MR. The goal of this research is to find an intrinsic combinatorial description of a particular family of these Hopf subalgebras. The simplest Hopf algebra in the family has a natural basis

given by permutations that I call Pell permutations. The Pell permutations are in bijection with combinatorial objects that I call sashes; that is, tilings of a 1 by n rectangle with three types of tiles: black 1 by 1 squares, white 1 by 1 squares, and white 1 by 2 rectangles. The bijection induces a Hopf algebra structure on sashes. I will describe the product and coproduct in terms of sashes, and the natural partial order on sashes. I also will discuss how the Hopf subalgebra relates to the larger family of Hopf subalgebras. (Received September 04, 2012)

1084-05-314 **Tracy McKay*** (mckaytr@dickinson.edu) and **Ryan Martin** (rymartin@iastate.edu).
On Determining the Edit Distance Function for Forb($K_{2,t}$).

The normalized edit distance from a graph G to a hereditary property $\mathcal{H}$ is the minimum number of edge additions and deletions necessary to make G a member of $\mathcal{H}$ divided by $\binom{n}{2}$. The limit as $n \to \infty$ of the maximum value of this quantity over all density-p, n-vertex graphs G, is the value of the edit distance function for $\mathcal{H}$ at p, denoted $ed_{\mathcal{H}}(p)$, where $p \in [0,1]$. It can be difficult to determine the entire edit distance function for a given hereditary property $\mathcal{H}$, but several techniques have been developed. This talk will look at strategies for calculating the edit distance function for Forb($K_{2,t}$), the hereditary property of having no induced $K_{2,t}$ subgraph for a fixed value of t, and how this problem relates to some other questions in extremal graph theory. (Received September 04, 2012)

1084-05-317 **Federico Ardila** and **Jeffrey Doker*** (jeff.doker@gmail.com).
Lifted generalized permutahedra and composition polynomials. Preliminary report.

Generalized permutahedra are the polytopes obtained from the permutahedron by changing the edge lengths while preserving the edge directions, possibly identifying vertices along the way. We introduce a "lifting" construction for these polytopes. We show how this construction gives rise to Stasheff's multiplihedron from homotopy theory, and to the more general "nestomultiplihedra", answering a question of Devadoss and Forcey.

We construct a subdivision of any lifted generalized permutohedron whose pieces are indexed by compositions. The volume of each piece is a polynomial, whose combinatorial properties we investigate. We show how this "composition polynomial" arises naturally in the polynomial interpolation of an exponential function. We prove that its coefficients are positive integers, and we conjecture that they are unimodal. (Received September 04, 2012)

1084-05-349 **Daniel Kalmanovich*** (dannykal@bgu.ac.il), **Mikhail Klin** and **Sven Reichard**.
Some transitive actions of groups PSL$(2,p)$ *and related discrete structures.* Preliminary report.

This project was originated by Eran Nevo together with the late William Thurston. A special tiling of a suitable hyperbolic space by octahedra was considered, producing a simplicial complex X with $v = \frac{p^2-1}{4}$ vertices, $e = \frac{p(p^2-1)}{8}$ edges and $t = \frac{p(p^2-1)}{6}$ triangles, such that PSL$(2,p)$ acts transitively on partial flags of X, here $p \equiv 1 \pmod 4$. In fact, the existence of X can be proved independently relying on the classical results by L. E. Dickson: the complete classification of the subgroups of the simple groups PSL$(2,p)$, p prime. From X we can construct an association scheme $\mathcal{M}$ of order v and a partially balanced incomplete block design. The automorphism group $Aut(\mathcal{M})$ contains a transitive action of PSL$(2,p)$ of degree v. The considered class of actions of PSL$(2,p)$ was used by R. Mathon for the construction of a wide class of antipodal covers of complete graphs, i.e., imprimitive distance regular graphs of diameter 3. This kind of transitive actions of the groups PSL$(2,p)$ can be considered in a wider framework. Intensive computer algebra experimentation (by MK and SR) yielded a new family of non-Schurian imprimitive association schemes with 3 classes. (Received September 04, 2012)

1084-05-363 **Michelle A Lastrina*** (lastrinm@dickinson.edu).
Sum-list-coloring graphs. Preliminary report.

Let $G = (V, E)$ be a graph and f be a function assigning list sizes to the vertices of G. The graph G is f-choosable if every assignment of lists of colors to the vertices of G, where the list sizes agree with f, has a proper list-coloring of G. The sum choice number is the minimum of the sum of list sizes for f over all choosable functions f for G. The sum choice number of G is at most $|V| + |E|$. When the sum choice number of G is equal to this upper bound, G is said to be sc-greedy. In this talk, we will discuss ways to determine whether or not a graph is sc-greedy and how to compute the sum choice number of a graph. In particular, graphs on a small number of vertices and some additional classes of graphs will be explored. (Received September 04, 2012)

1084-05-371 **María Ronco*** (mariaronco@inst-mat.utalca.cl). *Hopf structures on shuffle algebras and shuffle operads.*

The set $\mathcal{T}$ of all planar rooted trees, equipped with the grafting operations, determines a monad on the category of graded modules. D. Ginzburg and M. Kapranov described nonsymmetric operads as algebras over this monad.

The associahedron or Stasheff polytope $\mathfrak{A}_n$ of dimension $n-2$ is the geometric realization of the poset of planar rooted trees with n leaves, equipped with the Tamari order. If we replace the planar rooted trees by the surjection maps between finite sets, we get another family of polytopes: the permutohedra, denoted $\mathfrak{P}_n$. The grafting of planar rooted trees is replaced in this case by the action of shuffles. In a joint work with J.-L. Loday, we proved that the set of all surjective maps with substitution gives rise to a monad on arity graded modules, and an algebra over this monad is called a *permutad*.

The first part of the talk will be devoted to describe all the algebraic structures related to the associahedra. In the second part, we shall explain all the results we were able to extend to the permutohedron, as well as some questions and work in progress arising from them. (Received September 05, 2012)

06 ► Order, lattices, ordered algebraic structures

1084-06-70 **Nantel Bergeron*** (bergeron@yorku.ca), York University, Dept. of Mathematics and Stat., Toronto, Ontario M3J1P3, Canada, and **C. Berg**, **F. Saliola**, **L. Serrano** and **M. Zabrocki**. *Quasisymmetric functions for a poset of compositions and the Immaculate basis.*

In a recent paper on ArXive 1208.5191, we introduce the Immaculate basis of noncommutative symmetric functions. We introduce a poset of compositions and an associated quasisymmetric function that encode the structure constant of the immaculate basis. (Received September 04, 2012)

1084-06-125 **Sándor Jenei*** (jenei@ttk.pte.hu), Institute of Mathematics and Informatics, University of Pécs, Ifjúság u. 6., Pécs, 7624, Hungary. *Classification Results on Residuated Lattices.*

Ward and Dilworth, to investigate ideal theory of commutative rings with unit, introduced residuated lattices in the 30s of the last century. Examples of residuated lattices include Boolean algebras, Heyting algebras, MV-algebras, BL-algebras, and lattice-ordered groups; a variety of other algebraic structures can be rendered as residuated lattices. Ono introduced substructural logics; they encompass classical logic, intuitionistic logic, relevance logics, many-valued logics, mathematical fuzzy logics, linear logic and their non-commutative versions. The theory of substructural logics has put all these logics, along with many others, under the same motivational and methodological umbrella. Residuated lattices, being the algebraic counterpart of substructural logics just like Boolean algebras are for classical logic, have been the key component in this remarkable unification. Applications of substructural logics and residuated lattices span across proof theory, algebra, and computer science.

In this talk classification results on residuated lattices will be surveyed ranging from Hölder's precursor via Aczél, Clifford, Mostert, and Shields to the most recent ones.

Supported by the OTKA-76811 grant, the SROP-4.2.1.B-10/2/KONV-2010-0002 grant, and the MC ERG grant 267589. (Received August 28, 2012)

1084-06-210 **Cosimo Guido*** (cosimo.guido@unisalento.it), Dipartimento di Matematica, Via Arnesano, 73100 Lecce, Italy, and **Maria Emilia Della Stella**. *Algebras for lattice-valued mathematics.*

The development of lattice-valued mathematics and non-classical logics is based on a variety of lattice-ordered structures that suit for many-valued reasoning under uncertainty and vagueness. An order-theoretical approach to the algebras of logics is developed on the base of the following principle: "just like an order relation $\leq$ in a set L determines the lattice structure of L, each of its extensions relative to a true value $\top \in L$, e. g. any implication $\to$: $L \times L \to L$ s. t. for all $a, b \in L$: $a \leq b \Leftrightarrow a \to b = \top$, completely determines the richer lattice-ordered algebraic structure on L to be used either in classical or in non-classical logics.

The implicative structures $(L, \to, \top)$ so obtained have been specialized in a monograph of H. Rasiowa (1974) to characterize algebras of subsets and algebras of open sets; in recent papers of the authors, instead, it is shown how these structures include most algebras used in many-valued logics and lattice-valued mathematics, among which residuated lattices, MV algebras, quantales. Some applications to basic mathematical concepts are described to illustrate usefulness and appropriateness of these kinds of implicative structures for lattice-valued mathematics. (Received September 02, 2012)

1084-06-221 **Austin C Melton*** (amelton@kent.edu), Department of Mathematical Sciences, Kent State University, Kent, OH 44242. *Lattice-valued Galois Connections.*

A classical or crisp Galois connection is generated by a relation R between sets X and Y, i.e., $R \subseteq X \times Y$. In this setting, G. Birkhoff defined a Galois connection, originally called a poloarity, between the power sets of X and Y. The maps $f : \mathcal{P}(X) \to \mathcal{P}(Y)$ and $g : \mathcal{P}(Y) \to \mathcal{P}(X)$, which are used to form the Galois connection $(f, \mathcal{P}(X), \mathcal{P}(Y), g)$, are called Birkhoff operators.

Properties of Galois connections are reviewed, and then the relation R is generalized to a lattice-valued relation $R : X \times Y \to L$, where L is a complete lattice with additional structure. (For this talk, L will be a commutative, residuated semiquantale.) In this setting, the Birkhoff operators may be generalized to $H : L^X \to L^Y$ and $K : L^Y \to L^X$ to form the lattice-valued Galois connection (H, L^X, L^Y, K) where the partial orders on L^X and L^Y are point-wise. Classical Galois connection properties which generalize to the lattice-valued setting are discussed. (Received September 02, 2012)

1084-06-234 **Stephen E. Rodabaugh*** (serodabaugh@ysu.edu), Institute for Appl. Top. and Top. Structures, College of Science, Tech., Eng., Mathematics, Youngstown State University, Youngstown, OH 44406-1001. *Programming Semantics to Lattice-Valued Topology via Topological Systems.*

E. W. Dijkstra (1976) improved programs by focusing on outputs and predicates, postulating that deterministic programs comprise a "forward" input-to-output mapping and a "backward" mapping to pull output predicates back to input predicates. In 1983, M. Smyth advocated viewing predicates as open sets, with morphisms acting continuously between input and output "systems".

Unrelated were notions of L. A. Zadeh (1965), J. A. Goguen (1967, 1973), and C. L. Chang (1968) leading to S. E. Rodabaugh's (1981) schema of categories for "lattice-valued" topology, including **Loc-Top** comprising spaces (X, L, τ)—"carrier" set X, frame L of membership values, and subframe $\tau \subset L^X$—with "continuous" morphisms (f, φ), f a "forward" mapping between carrier sets and φ^{op} a "backward" mapping between frames of membership values.

Finally, S. J. Vickers (1989) proposed category **TopSys** comprising "topological systems"—a set, a locale of predicates, and a satisfaction relation reflecting the predicate frame structure into the powerset of the set—together with Dijkstra's programs as morphisms.

This talk links Dijkstra's ideas to lattice-valued topologies via topological systems. (Received September 03, 2012)

1084-06-271 **Michael Bukatin*** (bukatin@cs.brandeis.edu), **Ralph Kopperman** (rdkcc@ccny.cuny.edu) and **Steve Matthews** (steve.matthews@warwick.ac.uk). *Enrichment in Quantaloids: a Typed Enrichment for Categorical Description of Heterogenous Spaces.*

Typed enrichment is a situation where an arrow between objects X and Y is selected from a category determined by $(Type(X), Type(Y))$.

The enrichment in quantaloids is a version of enrichment in bicategories greatly simplified conceptually and technically by the restrictive requirement that the categories corresponding to $(Type(X), Type(Y))$ be complete lattices.

There has been a lot of interest in quantaloid enrichment in recent years. In particular, it was used to produce categorification of spaces of partially defined elements, such as lattice-valued sets and partial metric spaces.

This categorification sheds additional light on the meaning of the strong triangularity axiom of partial metrics, $P(X, Z) \leq P(X, Y) + P(Y, Z) - P(Y, Y)$. The typed composition, $P(X, Y) \circ_Y P(Y, Z) = P(X, Y) + P(Y, Z) - P(Y, Y)$, is defined in such a fashion that self-distances of partially defined points, $P(Y, Y)$, are units with respect to the composition $P(X, Y) \circ_Y P(Y, Z)$, despite those self-distances generally being non-zero. (Received September 03, 2012)

1084-06-329 **Michael Winter*** (mwinter@brocku.ca). *Categories of L-Fuzzy Relations.*

Relation algebras and categories of relations, such as allegories and Dedekind categories, establish a point-free and algebraic approach to the theory of binary relations. Lattice-valued relations, or L-fuzzy relations, are among the models of these algebraic and/or categorical theories. However, certain concepts such as crispness cannot be formulated using the algebraic language alone. Arrow and Goguen categories are an extension of categorical approach capable of expressing these additional concepts. In this talk we want to provide an overview of the theory of Goguen categories and related structures. In particular, we want to investigate their relationship, opportunities to define relational operators based on semigroup operations, the representation theory of Goguen

categories, and the uniqueness of the kernel operation with respect to a given Dedekind category. (Received September 04, 2012)

1084-06-369 **John R Harding*** (jharding@nmsu.edu), Department of Mathematical Sciences, New Mexico State University, Las Cruces, NM 88003. *Orders and type 2 fuzzy sets.*

The truth value object of type 2 fuzzy sets is the set M of all functions from the unit interval to itself equipped with various operations obtained as convolutions of the operations max, min, and negation, on the unit interval. These operations lead to not one, but two partial orders on M. Here we address matters connected to these orderings on M, including natural subsets on which they coincide, resulting lattice structures, equational properties, and a third order obtained as the intersection of the given two. (Received September 05, 2012)

11 ► Number theory

1084-11-19 **Katherine Alexander Anders*** (kaanders@illinois.edu), Department of Mathematics, 1409 W. Green St., Urbana, IL 61801. *An interesting family of polynomials in $\mathbb{Z}_2[x]$.* Preliminary report.

I describe a sequence of polynomials $p_n(x) \in \mathbb{Z}_2[x]$ such that the order of $p_n(x) = d_n$ and $p_n(x)q_n(x) = 1 + x^{d_n}$ with the property that the proportion of 1's among the coefficients of $q_n(x)$ goes to 1 as $n \to \infty$. (Received July 10, 2012)

1084-11-62 **Angel Kumchev***, Department of Mathematics, Towson University, Towson, MD 21252. *Diophantine inequalities with prime unknowns.* Preliminary report.

Let $\lambda_1, \dots, \lambda_s$ be nonzero real numbers, not all of the same sign and such that some ratio λ_i/λ_j is irrational. Let $D(k)$ denote the least integer s such that, under the above assumptions, the sums of the form $\lambda_1 p_1^k + \cdots + \lambda_s p_s^k$, where $p_1, \dots, p_s$ are primes, are dense in $\mathbb{R}$. The problem of estimating the function $D(k)$ is one of the standard versions for Diophantine inequalities of the classical Waring-Goldbach problem. In this talk, I will announce some new results on counting solutions of Diophantine inequalities with variables in diminishing ranges. Those results allow us to obtain new bounds for $D(4)$ and $D(5)$, which improve on the previously known results and close the gap between what is known about $D(k)$ and what is known about the Waring-Goldbach problem. (Received August 17, 2012)

1084-11-82 **Ernie Croot*** (ecroot@math.gatech.edu), Georgia Tech, School of Math, Atlanta, GA 30332, and **Albert Bush**, **Chris Pryby** and **Gagik Amirkhanyan**. *On a conjecture of Solymosi.*

We prove a theorem about lines in general position that are rich in an $n \times n$ grid $A \times A$. We show that for every $\epsilon > 0$ there exists $\delta > 0$ so that if one has n^ϵ lines in general position, they cannot all be $n^{1-\delta}$-rich in the grid $A \times A$. We will discuss the relationship between this problem and sum-product estimates, as well as results in incidence geometry, such as the Szemeredi-Trotter Theorem. (Received August 23, 2012)

1084-11-85 **Carl Pomerance*** (carl.pomerance@dartmouth.edu), Mathematics Department, Dartmouth College, Hanover, NH 03784, and **Douglas Ulmer** (douglas.ulmer@math.gatech.edu), School of Mathematics, Georgia Institute of Technology, Atlanta, GA 30332. *Balanced subgroups of the multiplicative group.*

Say a subgroup G of the multiplicative group modulo n is *balanced* if with the usual set of representatives, each coset of G has the same number of elements in the interval $(0, n/2)$ as in $(n/2, n)$. It was recently shown that this concept is related to the ranks of certain elliptic curves over function fields. In this paper we give a useful criterion for a subgroup to be balanced and we make progress towards a conjecture that almost all cyclic balanced subgroups belong to two simple families. (Received August 23, 2012)

1084-11-107 **Kevin Vissuet*** (kvissuet@gmail.com) and **Steven J Miller** (sjm1@williams.edu), WILLIAMSTOWN, MA 01267. *Most Sets are Balanced in many Finite Groups.*

The sumset is one of the most basic and important objects in additive number theory. Many of the biggest problems (such as Goldbach's conjecture, the Twin Prime conjecture, and Fermat's Last theorem) can be formulated in terms of the sumset $S + S = \{x + y : x, y \in S\}$ of a set of integers S. A finite set of integers A is sum-dominated if $|A + A| > |A - A|$. Though it was believed that the percentage of subsets of $\{0, \dots, n\}$ that are sum-dominated tends to zero, in 2007 Martin and O'Bryant proved a very small positive percentage are sum-dominated if the sets are chosen uniformly at random. Though most sets are difference dominated in the integer case, this is not the case when we take subsets of many finite groups. We show that if we take subsets

of larger and larger finite groups, then not only does the probability of a set being sum-dominated tend to zero but the probability that $|A+A| = |A-A|$ tends to one. We also show that in the Dihedral Group case, more sets are sum-dominated than difference-dominated. (Received August 27, 2012)

1084-11-108 **Steven J Miller*** (sjm1@williams.edu), **Amanda Bower** (amandarg@umd.umich.edu), **Rachel Insoft** (rinsoft@wellesley.edu), **Shiyu Li** (jjl2357@berkeley.edu) and **Philip Tosteson** (philip.d.tosteson@williams.edu). *Mind the Gap: Distribution of Gaps in Generalized Zeckendorf Decompositions.*

Zeckendorf proved that any integer has a unique decomposition as a sum of non-adjacent Fibonacci numbers, F_n. Using continued fractions, Lekkerkerker showed that the average number of summands for $m \in [F_n, F_{n+1})$ is essentially $n/(\phi^2+1)$, where ϕ is the golden ratio. Miller-Wang generalized this by adopting a combinatorial perspective, proving that for any positive linear recurrence $A_n = c_1 A_{n-1} + c_2 A_{n-2} + ... + c_L A_{n+1-L}$, the number of summands for integers in $[A_n, A_{n+1})$ converges to a Gaussian distribution as $n \to \infty$.

We prove that the probability of a gap larger than the recurrence length converges to decaying geometrically, with decay rate equal to the largest eigenvalue of the characteristic polynomial of the recurrence. These results hold both for the average over all m in $[A_n, A_{n_1})$, as well as holding almost surely for the gap measure associated to individual m. The techniques work for related problems, including the distribution of the longest gap between summands (which is similar to the distribution of the longest gap between heads in tosses of a biased coin), as well as for far-difference representations (where positive and negative summands are allowed). (Received August 27, 2012)

1084-11-138 **John Hoffman*** (jhoffma9@kent.edu), Department of Mathematical Sciences, Kent State University, Summit St, Kent, OH 44242, and **Gang Yu** (yu@math.kent.edu), Department of Mathematical Sciences, Kent State University, Summit St, Kent, OH 44242. *A ternary additive problem.* Preliminary report.

The problem of representing a large integer n in the form $n = m^2 + x^3 + y^5$ has been studied by a number of authors in the past decades. In this talk, we restrict m to square-free integers, and x, y to primes, and show that there is such a representation for all $n \le N$ with at most $O(N^{1-\frac{2}{105}+\epsilon})$ exceptions. We also improve the recent results of Z. Liu and C. Bauer on related problems. (Received August 29, 2012)

1084-11-167 **Enrique Treviño*** (etrevin1@swarthmore.edu), 500 College Avenue, Swarthmore, PA 19081. *A numerically explicit Burgess inequality and an application to quadratic non-residues.*

Let χ be a Dirichlet character $\bmod p$ for p a prime number. Let $S_\chi(M,N) = \sum_{M<n\le M+N} \chi(n)$. The celebrated Burgess inequality states that for M, N integers and r a natural number, $S_\chi(M,N) \ll_\varepsilon N^{1-1/r} p^{\frac{r+1}{4r^2}+\varepsilon}$. In this talk we give an explicit version of this inequality and we apply it to answer some questions regarding the least quadratic nonresidue $\bmod p$. (Received August 31, 2012)

1084-11-228 **Paul Pollack*** (pollack@uga.edu), Mathematics Department, Boyd Graduate Studies Research Center, University of Georgia, Athens, GA 30602, and **Lola Thompson**. *The degrees of the polynomial divisors of $x^n - 1$.*

We discuss what is known about the following questions concerning the degrees of the divisors of $x^n - 1$ in $\mathbb{Z}[x]$, as n ranges over the natural numbers:

(1) How often does $x^n - 1$ have **at least one** divisor of each degree $0 \le m \le n$?

(2) How often does $x^n - 1$ have **at most one** divisor of degree each degree $0 \le m \le n$?

(3) How often does $x^n - 1$ have **exactly one** divisor of each degree $0 \le m \le n$?

(4) For a given m, how often does $x^n - 1$ have a divisor of degree m?

Time permitting, we will also discuss what changes if $\mathbb{Z}$ is replaced by the finite prime field $\mathbb{F}_p$. These results represent work of Lola Thompson in her Ph.D. thesis as well as recent joint work of Lola with the speaker. (Received September 02, 2012)

1084-11-240 **Neil Lyall*** (lyall@math.uga.edu), Department of Mathematics, Athens, GA 30602, and **Alex Rice**. *Improvements and Extensions of Two Theorems of Sarkozy.*

We will discuss improvements and generalizations of two theorems of Sarkozy, the qualitative versions of which state that any subset of the natural numbers of positive upper density necessarily contains two distinct elements which differ by a perfect square, as well as two elements which differ by one less than a prime number, confirming conjectures of Lovasz and Erdos, respectively. Specifically, we shall discuss the recent thesis work of Alex Rice. (Received September 03, 2012)

1084-11-248 **Youness Lamzouri*** (lamzouri@mathstat.yorku.ca), York University, Department of Mathematics and Statistics, 4700 Keele St, Toronto, Ontario M3J1P3, Canada. *Prime Number Races.*

Although the primes are equidistributed in arithmetic progressions, it has been noted that certain residue classes tend to contain more primes in initial intervals of the positive integers. This phenomenon was first observed by Chebyshev in 1853. Since that time, "races" between primes in arithmetic progressions have been extensively studied. A prime number race $\{q; a_1, \dots, a_r\}$ is a game with r players, where at time t, the score of the j-th player is the number of primes less than t that are congruent to a_j modulo q. In this talk, I will review the history of this subject and discuss recent progress on prime number races with three or more competitors. (Received September 03, 2012)

1084-11-270 **Melvyn B. Nathanson*** (melvyn.nathanson@lehman.cuny.edu), Department of Mathematics, Lehman College (CUNY), Bronx, NY 10468. *Problems and results in additive number theory.*

This will be a survey of recent results and open problems in combinatorial and additive number theory. Of special interest are problems with a geometric flavor, including questions of growth of sumsets and product sets, and the large-scale geometry of the set of integers with metrics constructed from various finite and infinite generating sets. There are also generalizations of the Calkin-Wilf tree-enumeration of the positive rational numbers. (Received September 03, 2012)

1084-11-312 **Thai Hoang Le*** (leth@math.utexas.edu) and **Julia Wolf**. *On polynomial configurations in the primes.*

The Green-Tao theorem says that the primes contain arithmetic progressions of arbitrary length. Tao and Ziegler extended it to polynomial progressions, showing that configurations $\{a + P_1(d), \dots, a + P_k(d)\}$ exist in the primes, where $P_1, \dots, P_k$ are polynomials in $\mathbf{Z}[x]$ without constant terms (thus the Green-Tao theorem corresponds to the case where all the P_i are linear). We extend this result further, showing that we can add the extra requirement that d be of the form $p - 1$ (or $p + 1$) where p is prime. (Received September 04, 2012)

1084-11-366 **Izabella Laba*** (ilaba@math.ubc.ca), Department of Mathematics, UBC, Vanocuver, BC V6T1Z2, Canada. *Buffon's needle estimates and vanishing sums of roots of unity.*

Buffon's needle problem concerns estimates on the average (with respect to angle) length of 1-dimensional projections of finite iterations of planar Cantor sets. The purpose of the talk will be to present the recent results of Bond, Volberg, and the author. We will emphasize the number-theoretic aspects of the problem, including a surprising connection to the classic results of Redei, de Bruijn, Schoenberg, Mann, and others on the classification of vanishing sums of roots of unity. (Received September 04, 2012)

12 ► Field theory and polynomials

1084-12-129 **Chun-Yen Shen*** (cyshen@math.msu.edu), Department of Mathematics, Michigan State University, East Lansing, MI 48824. *Algebraic methods in sum-product phenomena.*

We classify the polynomials $f(x, y) \in \mathbb{R}[x, y]$ such that given any finite set $A \subset \mathbb{R}$ if $|A + A|$ is small, then $|f(A, A)|$ is large. In particular, the following bound holds : $|A + A||f(A, A)| \gtrsim |A|^{5/2}$. The Bezout's theorem and a theorem by Y. Stein play important roles in our proof. This confirms a conjecture of V. Vu. (Received August 28, 2012)

13 ► Commutative rings and algebras

1084-13-84 **Nicholas R Baeth*** (baeth@ucmo.edu) and **Alfred Geroldinger**. *Arithmetic of Monoids of Modules over Two-dimensional Rings.* Preliminary report.

Let $(R, \mathfrak{m})$ denote a two-dimensional normal domain such that its $\mathfrak{m}$-adic completion $\hat{R}$ is also a normal domain. Given the ideal class groups of R and $\hat{R}$ as well as the ideal classes represented by indecomposable torsion-free $\hat{R}$-modules, one can completely determine the monoid of isomorphism classes of torsion-free R-modules with operation given by direct sum. We will demonstrate this fact and then use well-known arithmetical invariants of commutative monoids to describe the uniqueness or non-uniqueness of direct-sum decompositions of torsion-free R-modules. (Received August 23, 2012)

1084-13-88 **David Hren*** (dhren@nmsu.edu), Department of Mathematical Sciences, P.O. Box 30001, Department 3MB, Las Cruces, NM 88003. *Fibers of Complete Scalar Extensions.*

Let $(R, \mathfrak{m})$ be a local, Noetherian domain with quotient field Q. Heinzer, Rotthaus, and Sally showed that $\dim \widehat{R} \otimes_R Q = \dim R - 1$ if and only if R is birationally dominated by a residually finite DVR by establishing a $1-1$ correspondence between prime ideals in the generic formal fiber of R of height $\dim R - 1$ and residually finite DVR overrings. In this talk, we discuss a generalization of their result using the notion of a complete scalar extension introduced by Schoutens. (Received August 23, 2012)

1084-13-99 **Hal Schenck**, **Alexandra Seceleanu** and **Javid Validashti*** (jvalidas@illinois.edu). *On Implicitization of Tensor Product Surfaces.*

A central problem in geometric modeling is to find the implicit equations for a curve or surface defined by a regular or rational map such as tensor product surfaces. In a joint work with H. Schenck and A. Seceleanu we classify all possible minimal free resolutions of the ideal associated to a tensor product surface S of bidegree $(2,1)$ in $\mathbb{P}^3$, which allows us to use the method of approximation complexes of Busé-Jouanolou, Busé-Chardin, Botbol-Dickenstein-Dohm to determine the implicit equation of S. (Received September 04, 2012)

1084-13-127 **Bruce Olberding*** (olberdin@nmsu.edu), Department of Mathematical Sciences, New Mexico State University, Las Cruces, NM 88003-8001, and **Francesca Tartarone** (tfrance@mat.uniroma3.it), Dipartimento di Matematica, Università degli Studi "Roma Tre", Largo San Leonardo Murialdo 1, 00146 Roma, Italy. *Integrally closed rings in birational extensions of two-dimensional regular local rings.*

Let D be an integrally closed local Noetherian domain of Krull dimension 2, and let f be a nonzero element of D. Motivated by the problem of classifying the integrally closed rings H between D and $D[1/f]$, we consider when H is determined locally by finitely many valuation overrings of D, in the sense that if M is a maximal ideal of H, then there are finitely many valuation overrings $V_1, \ldots, V_n$ of D such that $H_M = V_1 \cap \cdots \cap V_n \cap (D_f)_M$. (With such a representation, it is possible to describe the structure of the ring H_M in some detail.) In some central cases where D is a regular local ring and f is a regular parameter of D, then H is determined locally by a single valuation. As a "Noetherian" consequence, we show that with such a choice of D and f, if H is normalization of a finitely generated D-subalgebra of D_f, then the height one prime ideals of H lying over the maximal ideal of D are comaximal. Geometrically, this translates into a statement about intersections of irreducible components in the closed fiber of the normalization of a proper birational morphism. (Received August 28, 2012)

1084-13-128 **Jason Greene Boynton** (jason.boynton@ndsu.edu), Department of Mathematics, North Dakota State University, Fargo, ND 58108, and **Jim Coykendall*** (jim.coykendall@gmail.com), Department of Mathematics, North Dakota State University, Fargo, ND 58108. *A Geometric Approach to Atomicity and Factorization.*

It is well known that the group of divisibility contains copious information on the factorization structure of an integral domain. In this talk, we define a (directed) graph that shows what the group of divisibility of an integral domain "looks like". This will allow us to characterize some common factorization types of domains with a visual flavor. We will also show the graph of an integral domain is weakly connected if and only if the domain is "nearly" atomic. Additionally, the number of (weakly) connected components is a measure of how far the domain is from being "nearly" atomic. (Received August 28, 2012)

1084-13-155 **S. Spiroff*** (spiroff@olemiss.edu), Department of Mathematics, Hume Hall 305, P.O. Box 1848, University, MS 38677. *A comparison of dimensions and degrees, and the eta invariant.*

For a graded complete intersection R and finitely generated R-modules M and N, we compare the dimension of the tensor product of M and N with dim M + dim N – dim R, and relate these to a generalized version of Hochster's theta invariant, also known as Dao's eta invariant. Specifically, we give a Bézout-like result relating the degrees of M and N to the degrees of the torsion modules of M and N, the degree of R, and eta. Additional results are obtained when R has isolated singularity or the tensor product of M and N has finite length. (Received August 30, 2012)

1084-13-160 **Lokendra P. Paudel*** (lokendra@nmsu.edu), New Mexico State University, Department of Mathematical Sciences, Las Cruces, NM 88003. *Weak Approximation for Valuation Overrings of Affine Domains.*

The group of divisibility of an integral domain is the multiplicative group of nonzero principal fractional ideals of the domain. The goal of this presentation is to describe the lattice-ordered groups (l-groups) that occur as a group of divisibility of a Bézout overring of an affine domain $D = k[x_1, x_2, ..., x_n]$. We focus especially on the

finitely generated l-groups that arise as the group of divisibility of a finite intersection of valuation overrings of D. (Received August 30, 2012)

1084-13-166 **Simplice Tchamna*** (tchamna@nmsu.edu), Department of Mathematical Sciences, New Mexico State University, P.O. Box 30001, Department 3MB, Las Cruces, NM 88003-8001. *The Ideal Completion of a Noetherian Local Domain.*

The ideal topology on a commutative ring R is the topology which has a fundamental system of neighborhoods of 0 the nonzero ideals of R. Matlis used the ideal topology in his studies of torsion-free and cotorsion modules. We investigate the properties of the ideal topology on a Noetherian local domain (R, m), and we establish connections between the m-adic topology and the ideal topology. We will present the relations between the ideal completion and the m-adic completion of a local Noetherian domain. In particular, we will discuss the properties satisfied by one completion and not the other. We give conditions under which the completion in the ideal topology is Noetherian and we show that unlike the m-adic completion, the completion in the ideal topology is not always Noetherian. (Received August 30, 2012)

1084-13-170 **Christel Rotthaus*** (rotthaus@math.msu.edu), Michigan State University, Department of Mathematics, Wells Hall, East Lansing, MI 48824. *A class of coherent regular rings.* Preliminary report.

In 2007 Liana Sega and I constructed a certain class of coherent regular rings. This talk discusses possible generalizations of the 2007 result. Of particular interest is the construction of a larger class of coherent rings with a Noetherian completion. (Received August 31, 2012)

1084-13-185 **Youngsu Kim*** (kim455@purdue.edu), Department of Mathematics, Purdue University, 150 N. University Street, West Lafayette, IN 47907. *Quasi-Gorenstein Extended Rees Algebras.*

A ring is called quasi-Gorenstein if it is isomorphic to its own canonical module. A quasi-Gorenstein ring is Gorenstein if and only if it is Cohen-Macaulay. We show that for some classes of extended Rees algebras, the quasi-Gorenstein property implies the Gorenstein property. (Received August 31, 2012)

1084-13-193 **Olgur Celikbas**, **Srikanth Iyengar**, **Greg Piepmeyer** and **Roger Wiegand*** (rwiegand@math.unl.edu). *Vanishing of* Tor *over local rings.* Preliminary report.

Let R be a Noetherian local domain, and let M and N be finitely generated R-modules. We give various criteria, in terms of depth properties of M, N, and $M \otimes_R N$, that force vanishing of $\operatorname{Tor}_i^R(M, N)$ for all $i \geq 1$. In addition, we examine what one can learn from the assumption that $M \otimes_R N$ is torsion-free, or that the n-fold tensor power $M^{\otimes^n}$ of M is torsion-free. For example, if M has rank r and $M^{\otimes^{r+1}}$ is torsion-free, then M is free. (Received August 31, 2012)

1084-13-194 **William Heinzer** (heinzer@math.purdue.edu), 2400 Sheridan Blvd, Lincoln, 68502, **Christel Rotthaus** (rotthaus@math.msu.edu), Lincoln, 68502, and **Sylvia M Wiegand*** (swiegand@math.unl.edu), Math. Dept. UNL, Lincoln, NE 68502. *Power series over Noetherian rings.* Preliminary report.

We will discuss various applications of power series, such as for creating examples of interesting Noetherian and non-Noetherian rings. (Received September 01, 2012)

1084-13-218 **Tom Marley*** (tmarley1@unl.edu). *On FGFC rings.*

In a 1968 paper, Ohm and Pendleton examine several topological properties that may be possessed by the prime spectrum of a commutative ring R. One of these properties, which they call *FC* for 'finite components', is that every closed subset of $\operatorname{Spec} R$ has a finite number of irreducible components. Thus, R has FC if and only if every ideal I has a finite number of minimal primes. In general, this property does not pass to polynomial ring extensions. In this talk, we examine a weaker property called *FGFC* which says that the set of minimal primes over any finitely generated ideal is finite. We show that if R is FGFC then so is $R[X]$, where X is a (possibly infinite) set of indeterminates over R. (Received September 02, 2012)

1084-13-227 **Mark Batell*** (mark.batell@ndsu.edu) and **Jim Coykendall**. *A note on factorization in polynomial rings.* Preliminary report.

Let R be a domain with quotient field K. Recall that $\rho(R)$, the elasticity of R, is defined by $\rho(R) = \sup\{\frac{m}{n} |\ \alpha_1\alpha_2\cdots\alpha_n = \beta_1\beta_2\cdots\beta_m,\ \alpha_i, \beta_j \text{ irreducible}\}$. Ideally one would have $\rho(R) = 1$, because then all factorizations of an element of R into irreducibles have the same length. To show that $\rho(R) = 1$, a well-known strategy is the following or a variation of the following: find a domain T containing R such that $\rho(T) = 1$ and every irreducible element of R is irreducible in T. For example, a sufficient condition for the polynomial ring

$R[X]$ to have elasticity 1 is that every nonconstant irreducible polynomial $f \in R[X]$ be irreducible in $K[X]$. We will determine the integral domains R whose polynomial rings satisfy this condition. (Received September 02, 2012)

1084-13-232 **Ela Celikbas*** (celikbase@missouri.edu), 109A Math Sciences Bldg, Mathematics Department, University of Missouri, Columbia, MO 65211, and **Christina Eubanks-Turner** and **Sylvia Wiegand**. *Prime Ideals in Quotients of Mixed Power Series/Polynomial Rings.* Preliminary report.

In this talk we discuss sets of prime ideals in quotients of mixed power series-polynomial rings. For a one-dimensional Noetherian domain R, we describe prime spectra of certain two-dimensional quotients of mixed power series/polynomial rings over R, that is, $\mathrm{Spec}(R[[x]][y]/Q)$ and $\mathrm{Spec}(R[y][[x]]/Q')$, where x and y indeterminates and Q and Q' are certain height-one prime ideals of $R[[x]][y]$ and $R[y][[x]]$ respectively. (Received September 02, 2012)

1084-13-242 **Sean Sather-Wagstaff** and **Richard Wicklein*** (richard.wicklein@ndsu.edu). *Variations On A Result Of Lescot.* Preliminary report.

In 1990, Jack Lescot proved the following result.

Let $(R, \mathfrak{m}, k)$ be a noetherian, local ring.Let $\underline{x} = x_1, \dots, x_d$ be a minimal generating sequence for the maximal ideal $\mathfrak{m}$. $K(\underline{x})$ is the Koszul complex on the minimal generating sequence. Let M be an R-module. Then the following are equivalent.

(1) For all i, $0 \leq i \leq d$, the k-vector space $H_i(K(\underline{x}) \otimes_R M)$ is finite dimensional.

(2) For all $i \in \mathbb{N}$, the k-vector space $Tor_i^R(k, M)$ is finite dimensional.

(3) For all $i \in \mathbb{N}$, the k-vector space $Ext_R^i(k, M)$ is finite dimensional.

We will discuss some variations of Lescot's result when a minimal generating sequence for the maximal ideal is replaced by a generating sequence for an arbitrary ideal. (Received September 03, 2012)

1084-13-245 **Christopher Manon*** (cmanon@gmu.edu). *The combinatorial commutative algebra of $SL_3(\mathbb{C})$ conformal blocks.*

We discuss recent results on the commutative algebra of the Cox ring of the moduli of quasi-parabolic $SL_3(\mathbb{C})$ principal bundles on a smooth, marked curve. The multigraded components of this algebra show up as structure spaces of a tensor category derived from the representation theory of the quantum group $U_q(sl_3(\mathbb{C}))$, they can be identified with spaces known as "conformal blocks" in the WZNW model of conformal field theory, and their dimensions compute the structure coefficients of the small quantum cohomology of the Grassmannian variety $Gr_3(\mathbb{C}^n)$. We discuss a family of toric degenerations of this Cox ring, and use this degeneration to derive positive, polyhedral counting rules for the dimensions of its multigraded components. (Received September 03, 2012)

1084-13-268 **Sarah Glaz** and **Ryan Schwarz** (schwarzr1@newpaltz.edu). *Prüfer Conditions on Commutative Group Rings.*

In the domain context, Prüfer rings, locally Prüfer rings, Gaussian rings, arithmetical rings, rings of weak global dimension at most one, and semihereditary rings all coincide. Outside the domain context, however, these properties are not equivalent. We consider the behavior of these six extensions of the Prüfer domain notion in commutative group rings. In particular, we examine the ascent and descent of these properties between R and RG where R is a commutative ring and G is an abelian group. (Received September 04, 2012)

1084-13-281 **K Alan Loper*** (loper.4@osu.edu), Ohio State University, 1179 University Drive, Newark, OH 43055. *Intersections of collections of valuation domains.* Preliminary report.

We will consider what topological conditions placed on a collection of valuation domains all with a common quotient field will yield specific types of domains as the intersection of the collection. (Received September 03, 2012)

1084-13-282 **Thomas Dunn*** (thomas.dunn@ndsu.edu), NDSU Mathematics Dept #2750, North Dakota State Univsersity, PO Box 6050, Fargo, ND 58108. *A Linear Formula for the Generalized Multiplicity Sequence.*

For an arbitrary ideal I in a local ring R and R-module M, Achilles and Manaresi introduced the sequence of generalized multiplicities $c_k(I, M)$ $(k = 0, ..., \dim M)$ as a generalization of the classical Samuel multiplicity $e(I, M)$ of an $\mathfrak{m}$-primary ideal I. We prove a formula expressing each generalized multiplicity $c_k(I, M)$ as a linear combination of certain local multiplicities $c_0(IR_\mathfrak{p}, M_\mathfrak{p})$. As a consequence, when M is formally equidimensional, we prove that if $I \subseteq J$ and $c_k(I, M) = c_k(J, M)$ for all $k = 0, ..., \dim M$ then I is a reduction of (J, M). The

converse of this statement is also known to be true by a result of Ciupercă. This theorem gives a complete numerical characterization of integral closure, generalizing a well known theorem of Rees. (Received September 03, 2012)

1084-13-342 **Jason Greene Boynton*** (jason.boynton@ndsu.edu), NDSU Mathematics Dept #2750, Attn: Melanie, PO Box 6050, Fargo, ND 58108-6050, and **Jim Coykendall** (jim.coykendall@ndsu.edu), NDSU Mathematics Dept #2750, Attn: Melanie, PO Box 6050, Fargo, ND 58108-6050. *On Kaplansky's theorem for unique factorization domains.*

A well-known theorem of Kaplansky states that an integral domain is a unique factorization domain if and only if every nonzero prime ideal contains a prime element. Recall that a domain is called atomic if every nonzero nonunit admits a finite factorization into irreducible elements (atoms). Let D be an atomic integral domain and let $\mathrm{Irr}(D)$ be its set of irreducible elements. Given a factorization property F, we find a subset $X(F)$ of $\mathrm{Irr}(D)$ such that D has property F if and only if every nonzero prime ideal contains an element of $X(F)$. (Received September 04, 2012)

14 ► Algebraic geometry

1084-14-12 **Ivan Horozov*** (horozov@math.wustl.edu), Department of Mathematics, Washington University in St Louis, One Brookings Drive, St Louis, MO 63130, and **Matt Kerr**, Department of mathematics, Unversity of Washington in St Louis, One Brookings Drive, St Louis, MO 63130. *Reciprocity Laws on Algebraic Surfaces via Iterated Integrals.*

In this paper we define a new symbol, called the 4-function symbol, on a complex algebraic surface, which satisfies two types of reciprocity laws. In comparison the Parshin symbol on a surface is defined for 3 non-zero rational functions. Both the 4-function symbol and the Parshin symbol are expressed as a product of more primitive symbols, which we call bi-local symbols. They also satisfy reciprocity laws and occur naturally, when iterated integrals are used. The key technical ingredient is the notion of iterated integrals on membranes. In terms of such integrals, we not only prove reciprocity laws but we give an interpretation of the symbols as parallel transports on the loop space of a variety. Moreover, such integrals give a relation between the 4-function symbol and the Riemann curvature tensor.

The appendix contains a K-theoretic variant of the 4-function symbol, which differs by a sign. This difference causes one of the reciprocity laws to fail, suggesting that iterated integrals play an essential role in the definition of the (correct) 4-function symbol. (Received June 26, 2012)

1084-14-24 **Nathan Owen Ilten*** (nilten@math.berkeley.edu), Department of Mathematics, University of California, Berkeley, CA 94720. *Mutations of Laurent Polynomials and Flat Families with Toric Fibers.*

In recent work, I have shown that certain birational transformations mapping a Laurent polynomial to another Laurent polynomial correspond to deformations between the associated toric varieties. I will discuss this result and its relevance in the larger context of mirror symmetry and the classification of Fano varieties. (Received July 30, 2012)

1084-14-25 **Ursula Whitcher*** (whitchua@uwec.edu). *Short tops and semistable fibrations.*

Calabi-Yau hypersurfaces in toric varieties described by reflexive polytopes have been used to investigate the physical phenomenon known as mirror symmetry. If the intersection of a reflexive polytope with a hyperplane yields a lower-dimensional reflexive polytope slice, then the corresponding Calabi-Yau varieties are fibered by lower-dimensional Calabi-Yau varieties. A top generalizes the construction of the upper half of a sliced reflexive polytope. In contrast to the classification of reflexive polytopes, tops may arise in infinite families. We describe an algorithm for constructing infinite families of tops over an arbitrary reflexive base. All lattice points of the tops we construct have last coordinate either 0 or 1; we call such tops *short tops*. We show that four-dimensional short tops correspond to semistable degenerations of K3 surfaces, and five-dimensional short tops yield semistable degenerations of Calabi-Yau threefolds. The lattice points in the top control the structure of the degeneration. This talk describes joint work with two University of Wisconsin - Eau Claire undergraduates, Ryan Davis and Adam Gewiss. (Received July 31, 2012)

1084-14-44 **Amin Gholampour*** (aminghⓐmath.umd.edu), Department of Mathematics, University of Maryland, 1301 Mathematics Bldg, College Park, MD 20743. *Donaldson-Thomas invariants of Torsion 2-dimensional sheaves and modular forms.*

We study the Donaldson-Thomas invariants of the stable sheaves with 2-dimensional supports in a threefold. The DT invariants are defined by integrating over the virtual fundamental class (when exists). In the case where the ambient threefold is a smooth K3 surface fibration we express the DT invariants of the sheaves supported on the fibers in terms of the Euler characteristics of the Hilbert scheme of points on the K3 surface and the Noether-Lefschetz numbers of the fibration. We show that these invariants have modular properties as predicted by string theory. This is a joint work with Artan Sheshmani. (Received August 12, 2012)

1084-14-61 **Asher Auel** and **Marcello Bernardara*** (mbernardⓐmath.univ-toulouse.fr), Université P.Sabatier, Institut de Math. de Toulouse, 118 route de Narbonne, 31062 Toulouse, France, and **Michele Bolognesi** and **Anthony Várilly-Alvarado**. *Rational cubic fourfolds containing a plane with nontrivial Clifford invariant.* Preliminary report.

A very challenging question is to determine whether a smooth projective cubic fourfold X is rational or not, and to establish rationality criteria. For example no cubic fourfold is known to be not rational. It is known that X is rational either if X is Pfaffian or if X contains a plane and the associated quadric fibration admits a section.

Kuznetsov proposed the following conjecture: X is rational if and only if a distinguished subacategory $\mathbb{A}$ of the derived category $D(X)$ is equivalent to the derived category of a K3 surface. The conjecture holds true in the two previous cases.

If X contains a plane, one can associate to X a quadric fibration over $\mathbb{P}^2$, and a degree 2 K3 surface S. This determines an Azumaya algebra β on S, the Clifford invariant of X. The quadric fibration admits a section if and only if β is trivial. Kuznetsov establishes an equivalence between $\mathbb{A}$ and $D(S, \beta)$, proving the conjecture.

In this paper, we provide an example of a Pfaffian (hence rational and realizing Kuznetsov conjecture) X with nontrivial Clifford invariant. Moreover, we establish Hodge theoretic cirteria for a cubic fourfold containing a plane whose group of algebraic cycles of codimension 2 has rank 3 to have (non)trivial Clifford invariant. (Received August 16, 2012)

1084-14-66 **Anders Jensen** and **Josephine Yu*** (jyuⓐmath.gatech.edu). *Stable Intersection of Tropical Varieties.*

We give several characterizations of stable intersections of tropical varieties and locally balanced fans in general. For tropical hypersurfaces of polytopes, the multiplicity of stable intersection is the mixed volume. The stable intersection of tropical varieties is the tropical variety of a "perturbed" intersection of varieties. These facts together give a proof of the Bernstein's Theorem. We will also show that computing stable intersection is equivalent to computations in the polytope algebra of McMullen. (Received August 19, 2012)

1084-14-73 **Zsolt Patakfalvi*** (pzsⓐmath.princeton.edu). *Semi-positivity in positive characteristics.*

Results of Griffiths, Fujita, Kawamata, Viehweg, Kollár, etc. stating semi-positivity of relative canonical bundles and of the pushforwards of their powers were crucial in the development of modern algebraic geometry. Most of these results required the characteristic zero assumption, partially due to the use of Hodge theory. In this talk I present semi-positivity results in positive characteristics. The main focus is moduli theoretic situations, in which the best known results in positive characteristics were for families of stable curves by Szpiro and Kollár and for K3 surfaces by Maulik. I present results for arbitrary fiber dimensions allowing sharply F-pure (char p equivalent of log canonical) singularities and semi-ample or ample canonical sheaves for the fibers. I will also discuss some applications: projectivity of proper coarse moduli spaces, characteristic zero implications and a special case of subadditivity of Kodaira dimension in the above mentioned moduli setting. (Received August 21, 2012)

1084-14-94 **June Huh*** (junehuhⓐumich.edu), 512 Walnut St. #11, Ann Arbor, MI 48104. *The maximum likelihood degree of a very affine variety.*

We show that the maximum likelihood degree of a smooth very affine variety is equal to the signed topological Euler characteristic. This generalizes Orlik and Terao's solution to Varchenko's conjecture on complements of hyperplane arrangements to smooth very affine varieties. For very affine varieties satisfying a genericity condition at infinity, the result is further strengthened to relate the variety of critical points to the Chern-Schwartz-MacPherson class. The strengthened version recovers the geometric deletion-restriction formula of Denham, Garrousian, and Schulze for arrangement complements, and generalizes Kouchnirenko's theorem on the Newton polytope for nondegenerate hypersurfaces. (Received August 24, 2012)

1084-14-100 **Hal Schenck**, **Alexandra Seceleanu** and **Javid Validashti*** (jvalidas@illinois.edu). *On Syzygies and Singularities of Tensor Product Surfaces.*

Let $U \subseteq H^0(\mathcal{O}_{\mathbb{P}^1\times\mathbb{P}^1}(2,1))$ be a basepoint free four-dimensional vector space. We study the associated bigraded ideal $I_U \subseteq \mathsf{k}[s,t;u,v]$ from the standpoint of commutative algebra, proving that there are exactly six numerical types of possible bigraded minimal free resolution. These resolutions play a key role in determining the implicit equation for the image of the projective surface in $\mathbb{P}^3$ parametrized by generators of U over $\mathbb{P}^1 \times \mathbb{P}^1$. This problem arises from a real world application in geometric modeling, where one would like to understand the implicit equation and singular locus of a parametric surface. This talk is based on a joint work with H. Schenck and A. Seceleanu. (Received September 04, 2012)

1084-14-101 **CHING-JUI LAI*** (lai37@math.purdue.edu), Department of Mathematics, Purdue University, 150 N. University Street, West Lafayette, IN 47906. *Varieties fibered by good minimal models.*

Let X be a complex smooth projective variety. In the course of birational classification, the minimal model program (or Mori's program) predicts that X has a good minimal model if it has Kodaira dimension $\kappa(X) \geq 0$ and X is birational to a Mori fiber space (MFS) if $\kappa(X) = -\infty$. This has been established for varieties of general type, i.e. $\kappa(X) = \dim X$, by Birkar-Cascini-Hacon-M$^{\text{c}}$Kernan (BCHM). In this talk, we show that the existence of good minimal models for varieties with $0 < \kappa(X) < \dim X$ follows from the existence of good minimal models for varieties with $\kappa(X) = 0$. For the case where varieties has $\kappa(X) = 0$, the existence of good minimal models can be further reduced to the case of regular varieties with $\kappa(X) = 0$. On the other hand, the existence of MFS for varieties with negative Kodaira dimension can be derived from the Nonvanishing conjecture and a result of BCHM. If we have time, we will also talk about a non-vanishing theorem for irregular varieties. (Received August 26, 2012)

1084-14-104 **Mounir Nisse*** (nisse@math.tamu.edu), Department of Mathematics, College Station, TX 77843, and **Frank Sottile** (sottile@math.tamu.edu), Department of Mathematics College Station, TX 77843. *On the number of complement components of hypersurface coamoebas.* Preliminary report.

The coamoeba $co\mathcal{A}(V)$ of an algebraic variety $V \subset (\mathbb{C}^*)^n$ is its image under the argument map. The phase limit set of V, $\mathcal{P}^\infty(V)$, is the set of accumulation points of arguments of sequences in V with unbounded logarithm. The shell $\mathcal{H}(V)$ of a hypersurface coamoeba is the subset of $\mathcal{P}^\infty(V)$ bounded by the $(n-1)$-tori dual to the edges of the Newton polytope Δ of a polynomial defining the hypersurface. If $n > 2$, we show some inequalities between the number of connected components of $(S^1)^n \setminus \overline{co\mathcal{A}(V)}$, $(S^1)^n \setminus \mathcal{P}^\infty(V)$, and $(S^1)^n \setminus \mathcal{H}(V)$ to obtain the following:

$$\sharp\{(S^1)^n \setminus \overline{co\mathcal{A}(V)}\} \leq \sharp\{(S^1)^n \setminus \mathcal{P}^\infty(V)\} \leq \sharp\{(S^1)^n \setminus \mathcal{H}(V)\} \leq n!Vol(\Delta).$$

Moreover, we give an example of an integer polygon $\Delta_0 \subset \mathbb{R}^2$ where the last inequality is never sharp for any complex plane curve with such Newton polygon. Also, we have other examples of higher dimension where the inequality is not sharp. (Received August 26, 2012)

1084-14-120 **Dawei Chen*** (dawei.chen@bc.edu), Department of Mathematics, Boston College, Chestnut Hill, MA 02467. *Extremal effective divisors on moduli spaces of curves.*

We discuss several approaches to verify extremal effective divisors on moduli spaces of curves. (Received August 27, 2012)

1084-14-148 **Jason Lo*** (locc@missouri.edu), 202 Mathematical Sciences Building, University of Missouri, Columbia, MO 65211. *Stable complexes and Fourier-Mukai transforms.*

Fourier-Mukai transforms have been used to understand the relationships between various moduli spaces of sheaves, such as in the work of Bruzzo-Maciocia and Bridgeland-Maciocia. In this talk, I will give an example, on elliptic threefolds, where a Fourier-Mukai transform induces an open immersion from a moduli of complexes to a moduli of sheaves. If time permits, I will give another example, on K3 surfaces, where a Fourier-Mukai transform induces an isomorphism between a moduli of complexes and a moduli of sheaves. (Received August 29, 2012)

1084-14-154 **Eric Katz*** (eekatz@math.uwaterloo.ca), 200 University Avenue West, Waterloo, Ontario N2L 3G1, Canada. *Tropical geometry and the Hodge theory of hypersurfaces.*

We study the 'tropical motivic nearby fiber' of a subvariety of an algebraic torus which is a motivic invariant constructed from its tropicalization and initial degenerations. Under suitable conditions, this invariant specializes to the Hodge-Deligne polynomial of the limit mixed Hodge structure of a corresponding degeneration. We consider the special case of hypersurfaces and show that certain algebraic geometric invariants constructed from

the tropical motivic nearby fiber are well-behaved with respect to subdivision of the Newton polytope. From this, we give a new proof of some results of Danilov-Khovanskii on the χ_y-characteristic of hypersurfaces in algebraic tori. This is joint work with Alan Stapledon. (Received August 30, 2012)

1084-14-179 **Davide Fusi*** (davide.fusi@gmail.com), 155 South 1400 East, Salt Lake City, UT 84112, and **Tommaso de Fernex** (defernex@math.utah.edu), 155 South 1400 East, Salt Lake City, UT 84112. *RATIONALITY IN FAMILIES OF THREEFOLDS.*

In this joint work with Tommaso de Fernex, we prove that in a family of projective threefolds defined over an algebraically closed field, the locus of rational fibers is a countable union of closed subsets of the locus of separably rationally connected fibers. When the ground field has characteristic zero, this implies that the locus of rational fibers in a smooth family of projective threefolds is a countable union of closed subsets of the parameter space. (Received August 31, 2012)

1084-14-191 **Alexander A. Borisov*** (borisov@pitt.edu). *On the Log Discrepancies in Toric Mori Contractions.*

I will describe a joint work with Valery Alexeev on the following conjecture (proposed independently by J. McKernan and V. Shokurov):

Conjecture. For all Mori contractions from X to Y of given dimensions, for any positive epsilon there exists a positive delta, such that if X is epsilon-log terminal, then Y is delta-log terminal. We prove this conjecture in the toric case and discuss the dependence of delta on epsilon, which seems mysterious. (Received August 31, 2012)

1084-14-203 **Jihyeon Jessie Yang*** (jyang@math.mcmaster.ca), Department of Mathematics & Statistics, McMaster University, 1280 Main Street West, Hamilton, Ontario L8S 4K1, Canada. *Tropical Severi Varieties and Applications.*

The paper studies the tropicalizations of Severi varieties, which we call *tropical Severi varieties*. Severi varieties are classical objects in algebraic geometry. They are parameter spaces of plane nodal curves. On the other hand, tropicalization is an operation in tropical geometry, which turns subvarieties of an algebraic torus into polyhedral objects in real vector spaces. By studying the tropicalizations, it may be possible to transform algebro-geometric problems into combinatorial ones. In this paper, we find a partial description of tropical Severi varieties in terms of subdivisions of polygons. Given a subdivision of a polygon, we construct another parameter space. This space is a much simpler object than the given Severi variety and it describes the tropical Severi variety. We present two applications. First, we understand G.Mikhalkin's correspondence theorem in terms of tropical intersection theory. In particular, this provides a proof of the independence of point-configurations in the enumeration of tropical nodal curves. The second application is about Secondary fans. Secondary fans are purely combinatorial objects which parameterize the regular subdivisions of marked polygons. We provide a relation between tropical Severi varieties and Secondary fans. (Received September 01, 2012)

1084-14-219 **Sara Gharahbeigi*** (gharahbeigis@missouri.edu), Columbia, MO 65201. *Regularity of General Rational Curves on Hypersurfaces.*

We show that for general smooth rational curves on a general hypersurface of degree $d \leq N$ in $\mathbb{P}^N$, the restriction map of global sections is of maximal rank, and therefore the regularity index of such curves is as small as possible. (Received September 02, 2012)

1084-14-246 **Adrian Clingher*** (clinghera@umsl.edu), Department of Mathematics, Express Scripts Hall, One University Blvd., St. Louis, MO 63121. *K3 Surfaces of High Picard Rank.* Preliminary report.

The talk will focus on a special class of complex algebraic K3 surfaces of Picard rank 16 or higher. I will present a classification of these objects in terms of appropriate modular forms. (Received September 03, 2012)

1084-14-272 **Julie Rana*** (rana@math.umass.edu). *Boundary Divisors in the Moduli Space of Stable Quintic Surfaces.* Preliminary report.

The moduli space of minimal surfaces of general type with fixed invariants admits a well-known compactification, the moduli space of stable surfaces, introduced by Kollár-Shepherd-Barron and Alexeev. Here, stable surfaces are connected projective surfaces with ample canonical class and semi log canonical singularities. There are two natural loci in this moduli space which are Cartier divisors if certain conditions are met. One of these corresponds to normal surfaces which have a unique Wahl singularity. A different set of expected boundary divisors corresponds to surfaces with orbifold normal crossings with some conditions on the orbifold normal bundle. We discuss these surfaces in the case of stable quintics. (Received September 03, 2012)

1084-14-284 **Mikhail Mazin*** (mmazin@gmail.com), 17 Poplar ave., Stony Brook, NY 11790. *Jacobi Factors of Quasi-Homogeneous Plane Curve Singularities.*

We study combinatorics of cell decompositions of Jacobi factors of quasi-homogeneous plane curve singularities. The cells are enumerated by certain Young diagrams, and the dimensions of cells can be computed in a combinatorial way. The resulting combinatorial theory turns out to be related to a generalization of (q,t)-Catalan numbers, geometry of the Hilbert scheme of points in the complex plane, representation theory of double affine Hecke algebras, and knot invariants of the link of the singularity.

This is a joint work with Eugene Gorsky. (Received September 03, 2012)

1084-14-293 **Jose Luis Gonzalez***, jgonza@math.ubc.ca, and **Kalle Karu**, karu@math.ubc.ca. *Bivariant Equivariant Cobordism.*

We define operational versions of algebraic cobordism and equivariant algebraic cobordism. More generally, we associate a bivariant theory to any oriented Borel-Moore homology theory with exterior and intersection products. Our bivariant groups satisfy the expected properties from the classical intersection theory case, e.g., one recovers the original theory in the expected cases and there is a version of Poincaré duality. We also present some Kimura-type exact sequences for algebraic cobordism and for bivariant (equivariant) cobordism. We prove that in general, for theories satisfying the exactness of these sequences, operational equivariant cobordism can be computed as the inverse limit of the operational cobordisms of partial Borel-type constructions associated to the variety. We illustrate our results by computing the operational equivariant cobordism ring of arbitrary toric varieties. The results in this talk are from joint work with Kalle Karu. (Received September 04, 2012)

1084-14-297 **Mesut Şahin*** (mesutsahin@gmail.com), Department of Mathematics, Çankırı Karatekin University, 18100 Çankırı, Turkey. *Extensions of toric varieties.*

We start by introducing the notion of extension of a toric variety and illustrate how it is useful for extending some results and for verifying some conjectures appeared in literature. Namely, it gives rise to infinitely many toric varieties with a special property, such as being set theoretic complete intersection or arithmetically Cohen-Macaulay (Gorenstein) and having a Cohen-Macaulay tangent cone or a local ring with non-decreasing Hilbert function, from just one single example with the same property. (Received September 04, 2012)

1084-14-303 **Jason A Miller*** (millerj@math.osu.edu). *A degree formula for Borel orbit closures in the variety of complete conics.* Preliminary report.

This talk looks at a degree formula for certain subvarieties of the space X of complete conics. The space of complete conics can be made into a spherical variety for a natural reductive group action. Given a very ample G-line bundle L on this space, one can construct an associated Newton polytope $\mathbf{P}(L)$ which encodes a great deal of geometric information about X. I will show that there is an explicit correspondence between the Borel orbit closures and certain linear combinations of faces of $\mathbf{P}(L)$. For this correspondence, one can determine the degree of a B-orbit closure, with respect to the embedding given by L, by calculating the (suitably normalized) volume of the associated faces. This correspondence and degree formula are similar to correspondences and degree formulas that have already been shown to exist for smooth projective toric varieties and complete flag varieties. (Received September 04, 2012)

1084-14-305 **Gary Kennedy*** (kennedy@math.ohio-state.edu). *A conjectural degree formula for subvarieties of spherical varieties.* Preliminary report.

This is the first of two talks about recent work by Jason Miller. A spherical variety is a variety acted upon by a reductive group and having a dense orbit under the action of a Borel subgroup B. Given such a variety, together with a very ample divisor, one constructs an associated Newton polytope. Various special cases suggest that there is a way to set up a correspondence between the closures of certain B-orbits and faces of this polytope, in such a way that the degree of an orbit closure equals the sum of (suitably normalized) volumes of the corresponding faces. I will explain the following special cases:

(1) For a toric variety embedded by a very ample torus-invariant divisor, its degree is the volume of the entire associated polytope.
(2) For a general spherical variety, work of Brion-Kazarnovskii, Okounkov, and Kaveh shows that there is a such a formula for the entire variety.
(3) For a complete flag variety, Kiritchenko et al have shown how to set up a correspondence between Schubert varieties and faces of a Gelfand-Zetlin polytope, and from this they compute the Schubert variety's degree.

In a subsequent talk, Miller will explain how a similar formula appears to work for the classical space of complete conics. (Received September 04, 2012)

1084-14-310 **Dustin Cartwright*** (dustin.cartwright@yale.edu), Department of Mathematics, Yale University, PO Box 208283, New Haven, CT 06520-8283. *Tropical complexes.* Preliminary report.

Tropical complexes are simplicial complexes together with some additional data. Many of the properties of graphs studied in tropical geometry have higher-dimensional analogues for tropical complexes. Tropical complexes can come from degenerations of varieties, such as a Calabi-Yau hypersurface in a Fano toric variety. They can also be studied from a purely combinatorial perspective. I will introduce tropical complexes and their properties and discuss some examples and conjectures. (Received September 04, 2012)

1084-14-313 **Jenya Soprunova***, soprunova@math.kent.edu, and **Frank Sottile**. *Orientability of real toric varieties and lower bounds for real polynomial systems.* Preliminary report.

In our previous work we obtained a lower bound for the number of real solutions for some families of real polynomial systems in terms of the Newton polytope of the system. The key idea was to formulate the system as a fiber of a linear projection of a toric subvariety of the sphere. Then the topological degree of this projection gives a lower bound on the number of real solutions. Our current work strengthens those results by characterizing when the toric subvariety of the sphere is orientable. This is based on work of Nakayama and Nishimura, who characterized the orientability of smooth real toric varieties. (Received September 04, 2012)

1084-14-320 **Florian Block***, Department of Mathematics, University of California, Berkeley, Berkeley, CA 94720, and **Diane Maclagan** (d.maclagan@warwick.ac.uk), Mathematics Institute, University of Warwick, Coventry, CV4 7AL, United Kingdom. *A Tropical Approach to Computing Effective Cones.* Preliminary report.

Hyperplane complements can be compactified (by a succession of blow-ups) in a "wonderful" way, as introduced by DeConcini and Procesi. We study the effective cones of these wonderful compactifications. In particular, we give an algorithm to compute the effective cones in terms of tropical geometry and the underlying matroid of the hyperplane arrangement. Examples include the moduli space of genus 0 curves and the blow-up of the plane at n points. (Received September 04, 2012)

1084-14-344 **Howard M Thompson*** (hmthomps@umflint.edu), Mathematics Department, 402 Murchie Science Building, 303 East Kearsley Street, Flint, MI 48502-1950. *Multiplier Ideals of Certain Binomial Ideals.*

I will explain how to use toric geometry to produce a formula for the multiplier ideals of monomial space curves. We will discuss lattice ideals and higher dimesion as time permits. (Received September 04, 2012)

1084-14-355 **Roya Beheshti***, 1 Brookings Drive, Campus Box 1146, Saint Louis, MO 63105. *Spaces of rational curves on hypersurfaces.*

I will discuss some aspects of the geometry of moduli spaces of rational curves on Fano hypersurfaces in projective space and other homogeneous varieties. Part of this talk is based on joint work with Mohan Kumar. (Received September 04, 2012)

16 ► Associative rings and algebras

1084-16-30 **Pace P. Nielsen*** (pace@math.byu.edu), 318 TMCB, Brigham Young University, Provo, UT 84602. *The Bounded Nilradical.*

The set $B(R) = \{a \ : \ Ra$ is nil of bounded index$\}$ is an ideal. This was first proved by Amitsur, and then given another proof by Klein. Klein also proved that $B(R[x]) = B(R)[x]$. We provide new intuitive proofs for these facts which generalized to skew polynomial rings. Time permitting, we will discuss similar results for other nilpotence properties. (Received August 06, 2012)

1084-16-43 **Barbara L. Osofsky*** (osofskyb@member.ams.org), 1010 South Park Avenue, Highland Park, NJ 08904. *Compatible Ring Structures on Injective Hulls of Finitely Embedded Rings.* Preliminary report.

For R a ring with identity let E_R denote the injective hull of R_R and Λ the endomorphism ring of $E(R)$. We study the question of when there exists a ring structure on $E(R)$ which is compatible with right module multiplication by elements of R if R_R is finitely embedded (f.e.), i.e. essential over a finitely generated socle. If E_R is a rational extension of R_R then such a ring structure exists and is unique. We study nonrational extensions by working in a canonical injective hull $\mathbf{E}_R = \Lambda/\mathfrak{I}$ where $\mathfrak{I} = \{\lambda \in \Lambda : \lambda(1) = 0\}$. This approach enables us to obtain: (1) a characterization that shows that the injective hull of a right perfect f.e. ring has a compatible

multiplication iff the left action of R on the socle of R_R has a property computable using only the arithmetic of R and giving uniqueness iff R is right artinian; and (2) if R is commutative and has a Noether-Lasker primary decomposition, then $E(R)$ has a compatible ring structure iff all associated primes of R occur with multiplicity 1. (Received August 12, 2012)

1084-16-53 **Liping Li*** (lixxx480@umn.edu), Department of Mathematics, University of California, Riverside, Riverside, CA 92507. *Representations of Finite EI Categories.*

Finite EI categories are samll categories with finitely many objects such that every endomorphism is an isomorphism. Each of them can be regarded as a combination of an underlying poset and several finite groups. Examples of finite EI categories include finite groups, posets, fusion systems and orbit categories. In this talk we introduce the background of representations of finite EI categories, characterize finite EI categories with hereditary category algebras, and study in details the representation types of finite EI categories with two objects. (Received August 14, 2012)

1084-16-59 **Surjeet Singh*** (ossinghpal@yahoo.co.in), House No. 424, Sector 35A, Chandigarh, India. *Right artinian right serial rings.*

Let R be an indecomposable right artinian ring, $S = \{e_\alpha : \alpha \in G\}$ be a basic, orthogonal set of indecomposable idempotents in R. The index set G becomes a connected digraph. For each $\alpha \in G$, set $R_\alpha = e_\alpha R e_\alpha$, $J_\alpha = e_\alpha J e_\alpha$ and for each edge $\alpha \to \beta$ in G, set $M_{\alpha\beta} = e_\alpha R e_\beta$. Suppose R is right serial, then the following hold: (i) Each R_α is right artinian right serial (ii) each $M_{\alpha\beta} = e_{\alpha\beta} R_\beta$ for some $e_{\alpha\beta} \in J \backslash J^2$ (iii) if $\alpha \to \beta$, $\alpha \to \gamma$ in G, then $\beta = \gamma$. If G contains a cycle, we denote by $G_0 : 1 \to 2 \to ..n \to$ (iv) If an $\alpha \in G \backslash G_0$, then R_α is a division ring, (v) for an $\alpha \in G_0$, there exists a b_α such that $J_\alpha = b_\alpha R_\alpha$, and for any edge $\beta \to \gamma$ in G_0, $b_\beta e_{\beta\gamma} = e_{\beta\gamma} b_\gamma$. By using this system, a method to construct right artinian right serial rings is developed. (Received August 16, 2012)

1084-16-60 **Andre G. Leroy*** (andre.leroy@univ-artois.fr), Faculté Jean Perrin, 23 Rue J. Souvraz, 62300 Lens, France, **Adel Alahmadi** (adelnife2@yahoo.com), Department of Mathematics, Jeddah, Saudi Arabia, and **Surender K. Jain**, Department of Mathematics, Morton Hall, Athens, OH. *Singular matrices as products of idempotent matrices.* Preliminary report.

We say that a ring R has the IP property if any square singular matrix can be written as a product of idempotent matrices. Erdös showed that a field has the IP property and this was extended to the case of a division ring or an euclidean domain by Laffey. In the talk we will examine such factorizations over Bézout domains. In particular we will show that a crucial step towards proving the IP property for certain classes of rings is to show that the factorization property is true for 2×2 singular matrices. The importance of conditions such as stable range one and GE_2 will be emphasized. (Received August 16, 2012)

1084-16-97 **Bryan E Bischof*** (bryan.bischof@gmail.com), 1835 Fairchild Ave, Manhattan, KS 66502. *Deformations of Differential Operators.*

A classical paper of Hayashi presents a quantum Weyl algebra which both deforms the classical Weyl algebra and produces representations of $U_q(\mathfrak{g})$ analogous to the representation of $U(\mathfrak{g})$ through the Weyl algebras. More recently, Lunts and Rosenberg defined differential operators for noncommutative rings, and subsequently some quantum deformations of these algebras. We show that in fact Hayashi's algebras are subalgebras of differential operators on appropriately chosen rings. Further, we show induced representations of the quantum group are preserved through this embedding. Additionally, we show the relationship between this result and the quantum analog of the theorem of Beilinson-Berstein, and how to extend these results to more general deformations of graded rings. Finally, we show how to "untwist" the deformations of the differential operators into deformations of underlying rings, and vice-versa. (Received August 25, 2012)

1084-16-139 **Louis H. Rowen*** (rowen@math.biu.ac.il), 52900 Ramat-Gan, Israel. *Representability of algebras finite over their centers.*

(Joint work with L. Small)

An algebra R (not necesssarily associative) over a central subring Z, is called **representable** if, for a suitable field K, R is embeddable as a C-subalgebra of a finite dimensional K-algebra W. R is **strongly representable** if W can be taken to be the localization $S^{-1}R$ for some multiplicative submonoid S of Z.

The motivation comes from the associative theory, in which case we could take $W = M_n(K)$ for suitable n.

Beidar [**?**] proved that any associative algebra finite (as a module) over a commutative Noetherian affine algebra over a field is representable, and his theorem turns out to be required for other important theorems

in PI-theory. Anan'in proved more generally that every left Noetherian PI-algebra that is affine over a field is representable.

An algebra is called **weakly Noetherian** if it satisfies the ACC on ideals. We prove (with a straightforward argument):

Theorem A: If a weakly Noetherian algebra R is finite (as a module) over a central subalgebra Z which contains a field F_0, then R is a finite subdirect product of strongly representable algebras.

Theorem A fails when we weaken its hypotheses. Other related results are also presented. (Received August 29, 2012)

1084-16-143 **Christopher Holston** and **Sergio R. Lopez-Permouth*** (lopez@ohio.edu), Department of Mathematics, Ohio University, Athens, OH 45701, and **Joseph Mastromatteo** and **Jose E Simental-Rodriguez** (jesr_@hotmail.com). *An alternative perspective on projectivity of modules.*

We approach the analysis of the extent of the projectivity of modules from a fresh perspective as we introduce the notion of relative subprojectivity. A module M and is said to be *N-subprojective* if for every epimorphism $g : B \to N$ and homomorphism $f : M \to N$, there exists a homomorphism $h : M \to B$ such that $gh = f$. For a module M, the *subprojectivity domain of M* is defined to be the collection of all modules N such that M is N-subprojective. We consider, for every ring R, the subprojective profile of R, namely, the class of all subprojectivity domains for R modules. We show that the subprojective profile of R is a semilattice, and consider when this structure has coatoms or a smallest element. Modules whose subprojectivity domain is smallest as possible will be called *subprojectively poor* (*sp-poor*) or *projectively indigent* (*p-indigent*) and those with co-atomic subprojectivy domain are said to be *maximally subprojective*. This work is a natural continuation to recent papers that have embraced the systematic study of the injective, projective and subinjective profiles of rings. (Received August 29, 2012)

1084-16-151 **Noyan Er***, noyaner@yahoo.com. *Rings whose cyclic modules have indecomposable decompositions: From Osofsky Theorem to Osofsky-Smith and on.*

We will talk about recent developments related to the well-known results mentioned in the title and some applications. Part of the talk involves joint work with P. Aydoğdu and N. O. Ertaş. (Received August 29, 2012)

1084-16-163 **Nguyen Viet Dung*** (nguyend2@ohio.edu), Department of Mathematics, Ohio University, Zanesville Campus, Zanesville, OH 43701. *Tilting modules and pure semisimple rings.*

A ring R is called left pure semisimple if every left R-module is a direct sum of finitely generated modules, or equivalently, if every left R-module is pure-injective. It is well known that left and right pure semisimple rings are precisely rings of finite representation type, and it is still an open problem whether left pure semisimple rings always have finite representation type. A finitely generated left R-module M is a tilting module if the class $\mathrm{Gen}(M)$ of all left R-modules generated by M coincides with the class $M^{\perp}$ of all left R-modules X that satisfy $Ext^1_R(M, X) = 0$. In this talk, we focus on the class of left pure semisimple hereditary rings R, and describe the distribution of indecomposable left R-modules over such a ring R. We show that the tilting property of certain finitely generated modules and properties of their endomorphism rings give useful information about the category of finitely generated left R-modules. In particular, we discuss the endofiniteness of indecomposable left R-modules. (This is joint work with José Luis García, University of Murcia, Spain) (Received August 30, 2012)

1084-16-171 **Gaohua Tang** and **Yiqiang Zhou*** (zhou@mun.ca), Department of Mathematics and Statistics, Memorial University of Newfoundland, St.John's, NL A1C 5S7, Canada. *A Class of Formal Matrix Rings.* Preliminary report.

Given a ring R, our concern is about the formal matrix ring $\mathbb{M}_n(R; s)$ over R defined by a central element s of R. When $s = 1$, $\mathbb{M}_n(R; s)$ is just the matrix ring $\mathbb{M}_n(R)$, but generally $\mathbb{M}_n(R; s)$ can be significantly different from $\mathbb{M}_n(R)$. In this talk, we will present some basic properties of the ring $\mathbb{M}_n(R; s)$, address the isomorphism problem between these rings, and discuss extending some known results from a matrix ring to the formal matrix ring $\mathbb{M}_n(R; s)$. (Received August 31, 2012)

1084-16-195 **Xianhui Fu** (fuxianhui@gmail.com), Department of Mathematics and Statistics, Northeast Normal University, Changchun, Peoples Rep of China, **Pedro A. Guil Asensio*** (paguil@um.es), Department of Mathematics, University of Murcia, Murcia, Spain, **Ivo Herzog** (iherzog@lima.ohio-state.edu), The Ohio State University at Lima, Lima, OH , and **Blas Torrecillas** (btorreci@ual.es), Department of Algebra and Functional Analysis, University of Almeria, Almeria, Spain. *Ideal approximation theory.*

Let $(\mathcal{A};\mathcal{E})$ be an exact category and F, a subfunctor of Ext. We define the notions of phantom morphism relative to F, and of special precovering ideal of $(\mathcal{A};\mathcal{E})$. We show that, when the exact category $(\mathcal{A};\mathcal{E})$ has enough injective objects and projective morphisms, then an ideal I of $\mathcal{A}$ is special precovering if and only if there is a subfunctor F of Ext with enough injective morphisms such that I is the ideal of F-phantom morphisms. We apply this result to show that several well-known ideal cotorsion pairs are complete. Namely, the ideal cotorsion pair cogenerated by the pure-injective modules of R-Mod; the ideal cotorsion pair cogenerated by the contractible complexes in the category of complexes $Ch(R-\text{Mod})$; and the ideal cotorsion pair cogenerated by the Jacobson radical $Jac(A-\text{mod})$ of the category A-mod of finitely generated representations of an Artin algebra A. (Received September 01, 2012)

1084-16-214 **Andrew Conner*** (connerab@wfu.edu), **Ellen Kirkman**, **James Kuzmanovich** and **Frank Moore**. *Finiteness conditions on the cohomology of monomial algebras.*

Let A be a finitely presented monomial algebra over a field k. Following C. Phan, we associate to A a finite directed graph $\Gamma(A)$ which encodes a minimal graded projective resolution of ${}_Ak$. The Gelfand-Kirillov dimension of the Yoneda algebra $\text{Ext}_A(k,k)$ is easily described in terms of walks in $\Gamma(A)$.

After imposing some additional structure on $\Gamma(A)$, we also combinatorially characterize the Yoneda product on $\text{Ext}_A(k,k)$. Our characterization yields combinatorial descriptions of finite generation and the Noetherian property. In particular, we show that determining if $\text{Ext}_A(k,k)$ is finitely generated is a finite problem. (Received September 02, 2012)

1084-16-236 **Pere Ara*** (para@mat.uab.cat), Departament de Matemàtiques, Edifici C, Universitat Autònoma de Barcelona, 08193 Bellaterra, Barcelona, Spain, and **Ruy Exel** (exel@mtm.ufsc.br), Departamento de Matemática, Universidade Federal de Santa Catarina, Florianópolis, 88010-970, Brazil. *Leavitt path algebras of separated graphs and paradoxical decompositions.* Preliminary report.

A separated graph is a pair (E,C), where E is a directed graph, $C=\bigsqcup_{v\in E^0}C_v$, and C_v is a partition of $r^{-1}(v)$ (into pairwise disjoint nonempty subsets) for every vertex v. (In case v is a source, we take C_v to be the empty family of subsets of $r^{-1}(v)$.) Leavitt path algebras $L_K(E,C)$ of separated graphs have been recently defined by Goodearl and the presenter.

We attach to a finite bipartite separated graph (E,C) a partial dynamical system $(\Omega(E,C),\mathbb{F},\alpha)$ possessing a certain universal property. Here $\Omega(E,C)$ is a 0-dimensional metrizable compact space, $\mathbb{F}$ is a finitely generated free group, and α is a partial action of $\mathbb{F}$ on $\Omega(E,C)$. The corresponding crossed product algebra $C_K(\Omega(E,C))\rtimes_{\alpha^*}\mathbb{F}$ is a certain *quotient* of $L_K(E,C)$, and we are able to compute its $\mathcal{V}$-monoid by utilizing a suitable representation as a direct limit of Leavitt path algebras of separated graphs. We will provide an application of this theory to a problem on paradoxical decompositions. (Received September 03, 2012)

1084-16-257 **Gangyong Lee**, 231 W 18th Ave, Columbus, OH 43210, **S. Tariq Rizvi*** (rizvi.1@osu.edu), 4240 Campus Drive, Lima, OH 45804, and **Cosmin Roman** (cosmin@mah.ohio-state.edu), 4240 Campus Drive, Lima, OH 45804. *(D-)Rickart modules and endomorphism rings.*

Let R be any ring, M be an R-module and $S=End_R(M)$. M is called a *Rickart module* if the right annihilator in M of any single element of S is a direct summand of M, i.e., $r_M(\varphi)=Ker\varphi\leq^{\oplus}M$ for every $\varphi\in S$. Dually, we say M is a *D-Rickart module* if $Im\varphi$ is a direct summand of M. We will present some results related to these notions with a special emphasis on the properties of the endomorphism ring $S=End_R(M)$ and its classification. Examples which delineate the concepts and results will also be presented. (Received September 03, 2012)

1084-16-326 **Vladimir Bavula*** (v.bavula@sheffield.ac.uk), Department of Pure Mathematics, University of Sheffield, Hounsfield Road, Sheffield, S3 7RH, United Kingdom. *An analogue of the Dixmier Conjecture is true for the algebra of polynomial integro-differential operators.*

In 1968, Dixmier posed six problems for the algebra of polynomial differential operators, i.e. the Weyl algebra. In 1975, Joseph solved the third and sixth problems. In 2005, I solved the fifth problem and gave a positive solution to the fourth problem but only in the case of homogeneous differential operators. The remaining three

problems are still open. The first problem/conjecture of Dixmier (which is equivalent to the Jacobian Conjecture as was shown in 2005-07 by Tsuchimito, Belov and Kontsevich) claims that the Weyl algebra 'behaves' like a finite field. In more detail, the Dixmier Conjecture/Problem: is true that an algebra endomorphism of the Weyl algebra an automorphism? In 2010, I proved that this question has an affirmative answer for the algebra of polynomial integro-differential operators. In my talk, I will explain the main ideas, the structure of the proof and recent progress on the Dixmier Conjecture. (Received September 04, 2012)

1084-16-338 **Dinh Van Huynh*** (huynh@ohio.edu), 321 Morton Hall, Ohio University, Dept of Mathematics, Athens, OH 45701. *ON THE HEREDITY OF V-MODULES OVER NOETHERIAN NONSINGULAR RINGS.*

A right module M_R over a ring R is called a V-module if every simple right R-module is M-injective. A module N_R is defined to be hereditary if every submodule of N is projective. With these concepts, our earlier result with H. Dinh and Ch. Holston (2012) can be restated in the form: a V-module P_R over a prime right noetherian ring R is hereditary if and only if R_R is hereditary and P is R-projective.

In this talk we consider the general case for a right noetherian right nonsingular ring R having a nonsingular V-module P_R, and show that all uniform right ideals $U \subseteq R$ which are embedded in P_R generate a nonzero two-sided ideal $\mathcal{U}_P(R) \subseteq R$, and $(\mathcal{U}_P(R))_R$ is a V-module. Further we show that, if $\mathcal{U}_P(R)_R$ is hereditary, then P_R is hereditary if and only if P is $\mathcal{U}_P(R)$-projective. If R is a right noetherian right hereditary ring, then all R-projective V-modules P_R are hereditary. In this case, $\mathcal{U}_P(R)_R = R$ for all nonsingular V-modules P_R.

We will discuss the case when the heredity of P_R implies that of $\mathcal{U}_P(R)_R$. This is a joint work with Hai Q. Dinh. (Received September 04, 2012)

18 ► Category theory; homological algebra

1084-18-69 **S. Estrada*** (sestrada@um.es), Departamento de Matematica Aplicada, Campus del Espinardo, 30100 Murcia, Murcia, Spain, and **Manuel Saorin**. *Locally finitely presented categories with no flat objects.*

If X is a quasi–compact and quasi–separated scheme, the category $Qcoh(X)$ of quasi–coherent sheaves on X is locally finitely presented. Therefore categorical flat quasi–coherent sheaves in the sense of Stenström naturally arise. But there is also the standard definition of flatness in $Qcoh(X)$ from the stalks. So it makes sense to wonder the relationship (if any) between these two notions. In the talk we show that there are plenty of locally finitely presented categories having no other categorical flats than the zero object. As particular instance, we show that $Qcoh(\mathbf{P}^n(R)))$ has no other categorical flat objects than zero, where R is any commutative ring. (Received August 20, 2012)

1084-18-124 **Sergejs Solovjovs*** (solovjovs@math.muni.cz), Department of Mathematics and Statistics, Faculty of Science, Masaryk University, Kotlarska 2, 611 37 Brno, Czech Rep. *Tower extension of topological categories.*

Given a topological construct $\mathbf{C}$ and a completely distributive lattice L, D. Zhang presented in 2000 a procedure of obtaining a new topological construct $\mathbf{C}(L)$, called the *tower extension of* $\mathbf{C}$ *w.r.t.* L, which provided a common setting for various existing topological machineries (e.g., the construction of the category of *approach spaces* of R. Lowen). Being implicitly a kind of a fuzzification of topological constructs, tower extension of D. Zhang fails to be well related to fuzzy topology. To remove the deficiency, we present its "partial" dualization called *tower extension of topological categories*, which, firstly, is applicable to (almost) every topological category; secondly, is variable-basis, namely, can rely on a whole category of lattice-theoretic structures in the sense of S. E. Rodabaugh; and, thirdly, for suitable categories $\mathbf{C}$, it produces the categories of fuzzy topological spaces in the sense of U. Höhle, T. Kubiak and A. Šostak. As a consequence, we conclude that the fuzzification framework of U. Höhle, T. Kubiak, A. Šostak and the approach framework of R. Lowen are "partially" dual to each other.

The research was supported by the ESF Project Nr. CZ.1.07/2.3.00/20.0051 of the Masaryk University. (Received August 28, 2012)

19 ► K-theory

1084-19-216 **Xiaolei Wu*** (xwu@math.binghamton.edu), Department of Mathematics, Suny Binghamton, Binghamton, NY 13902. *Farrell-Jones Conjecture for* $\mathbb{Z}[\frac{1}{p}] \rtimes_\alpha \mathbb{Z}$.

In this talk, I will present my joint work with Prof. Tom Farrell. Our main result is that we proved the Farrell-Jones Conjecture for $\mathbb{Z}[\frac{1}{p}] \rtimes_\alpha \mathbb{Z}$, where α is multiplication by a prime number p. I will first introduce the conjecture and explain why it is important. Then I will sketch the proof. (Received September 02, 2012)

1084-19-315 **Kyle Joecken*** (joecken@math.osu.edu), Department of Mathematics, The Ohio State University, 231 W 18th Ave, Columbus, OH 43210. *Dimension of Classifying Spaces with Virtually Cyclic Stabilizers for Certain Three-Dimensional Geometry Groups.* Preliminary report.

Let Γ be a uniform lattice in certain three-dimensional geometry groups (e.g. the universal cover of $\mathrm{PSL}_2(\mathbb{R})$). We give estimates for the minimal possible dimension of a model for $\underline{\underline{E}}\Gamma$, the classifying space of Γ with isotropy in the family of virtually cyclic subgroups of Γ. (Received September 04, 2012)

20 ► Group theory and generalizations

1084-20-4 **Ronald Mark Solomon*** (solomon.1@osu.edu), 2090 Iuka Avenue, Columbus, OH 43201. *Finite Groups and Beyond.*

The completion of the classification of the finite simple groups in 2004 by Aschbacher and Smith is a monumental milestone in the field. It has enabled the verification of numerous old conjectures, most recently Brauer's Height Zero Conjecture. However, deep facts beg for explanations, not merely taxonomic verifications. I shall describe some recent developments in the new area of saturated fusion systems (Frobenius categories), which offer hope of shedding new light on these matters. (Received July 31, 2012)

1084-20-7 **Hung Ngoc Nguyen**, **Hung P. Tong-Viet** and **Thomas P Wakefield*** (tpwakefield@ysu.edu), Department of Mathematics and Statistics, Youngstown State University, One University Plaza, Youngstown, OH 44555. *Projective special linear groups* $PSL_4(q)$ *are determined by the set of their character degrees.*

In the late 1990s, Bertram Huppert conjectured that if G is a finite group and H a finite nonabelian simple group such that the sets of character degrees of G and H are the same, then $G \cong H \times A$, where A is an abelian group.

Huppert verified the conjecture for many nonabelian simple groups, including many of the sporadic simple groups. There has been much interest and progress in the verification of this conjecture for families of simple groups of Lie type of rank two, the remaining sporadic simple groups, and alternating groups of low rank. In this presentation, we discuss arguments to confirm the conjecture for the family of projective special linear groups $\mathrm{PSL}_4(q)$ for $q \geq 13$. (Received June 18, 2012)

1084-20-23 **Mark L Lewis** and **Donald L. White*** (white@math.kent.edu), Department of Matematical Sciences, Kent State University, Kent, OH 44242. *Four-Vertex Degree Graphs of Nonsolvable Groups.*

For a finite group G, the character degree graph $\Delta(G)$ is the graph whose vertices are the primes dividing the degrees of the ordinary irreducible characters of G, with distinct primes p and q joined by an edge if pq divides some character degree of G. We determine all graphs with four vertices that occur as $\Delta(G)$ for some nonsolvable group G. Along with previously known results on character degree graphs of solvable groups, this completes the classification of all four-vertex graphs that occur as $\Delta(G)$ for some finite group G. (Received July 30, 2012)

1084-20-42 **Stephen D Smith*** (smiths@math.uic.edu). *Some remarks on Oliver's p-group conjecture.* Preliminary report.

After proving the Martino-Priddy Conjecture on p-fusion systems, Oliver observed that for odd p, an easier proof would follow from showing that the Thompson subgroup $J(P)$ (for a Sylow p-group P) should lie in another normal subgroup he denoted by $X(P)$.

The literature now contains various partial results—especially addressing the stronger conjecture that a faithful failure-of-factorization module V for P should admit an element of $Z(P)$ acting quadratically.

The talk will survey some of the results in the literature; and add a few elementary remarks, using the viewpoint of embedding P in a full unipotent group on V. (Received August 12, 2012)

1084-20-47 **Daniel E. Frohardt*** (danf@math.wayne.edu), Department of Mathematics, Wayne State University, Detroit, MI 48202, and **Robert Guralnick** and **Kay Magaard**. *Primitive Monodromy Groups of Genus at most Two.*

Let G be a transitive subgroup of S_n with generators $\sigma_1, \ldots, \sigma_r$ such that $\prod \sigma_i = 1$. The *genus* g of this system of generators is defined to be the non-negative integer $\left(\sum Ind(\sigma_i) - 2(n-1)\right)/2$, where $Ind(\sigma)$ is the permutation index of σ. It follows from Riemann's Existence Theorem that G is the monodromy group of a covering of the Riemann sphere by a compact Riemann surface of genus g.

It is known that for fixed genus g there is a finite set $\mathcal{E}(g)$ of simple groups such that every non-abelian composition factor of G is either an alternating group or a member of $\mathcal{E}(g)$. I will discuss progress toward determining the minimal set $\mathcal{E}(g)$ explicitly for small values of g. The present result bounds n when G has a composition factor in $\mathcal{E}(g)$, $g \leq 2$, G acts primitively, and G is an almost simple group of Lie type acting in a point action. I will also explain the significance of this last condition. (Received August 13, 2012)

1084-20-52 **I. M. Isaacs*** (isaacs@math.wisc.edu), **Maria Loukaki** and **Alexander Moreto**. *The average degree of an irreducible character.*

Let G be a finite group, and write $\mathrm{acd}(G) = \sum \chi(1)/|\mathrm{Irr}(G)|$, where the sum runs over $\chi \in \mathrm{Irr}(G)$. Then $\mathrm{acd}(G)$ is the average of the degrees of the irreducible characters of G, and it is easy to see that $\mathrm{acd}(G) = 1$ if and only if G is abelian. This suggests that if $\mathrm{acd}(G)$ is small, then G should be "almost" abelian. We show that if $\mathrm{acd}(G) \leq 3$, then G is solvable. (Since $\mathrm{acd}(A_5) = 3.2$, our result is probably not best-possible.) We also show that G is supersolvable if $\mathrm{acd}(G) \leq 3/2$ and G is nilpotent if $\mathrm{acd}(G) \leq 4/3$. (Received August 14, 2012)

1084-20-77 **David H Gluck*** (dgluck@math.wayne.edu), Detroit, MI 48202. *Rational Defect Groups and 2-Rational Characters, II.*

Let D be a defect group of a 2-block B of a finite group. We conjecture that if D is rational and of nilpotence class at most 2, then the values of every character in $\mathrm{Irr}(B)$ lie in a cyclotomic field $\mathbf{Q_m}$ for some odd integer m. We prove the conjecture when B has maximal defect. (Received August 22, 2012)

1084-20-109 **YONG YANG*** (yangy@uwp.edu), 900 Wood Road, Kenosha, WI 53144. *Solvable Permutation Groups and Orbits on Power Set.*

A permutation group G acting on a set Ω induces a permutation group on the power set $P(\Omega)$. Let G be a finite permutation group of degree n and let $s(G)$ denote the number of set-orbits of G. We determine $\inf(\frac{\log_2 s(G)}{n})$ over all solvable groups G. This answers a question of Babai and Pyber 'Permutation groups without exponentially many orbits on the power set', J. of Comb. Theory, Series A, 66 (1994), 160-168. (Received August 27, 2012)

1084-20-111 **Xiangdong Xie*** (xiex@bgsu.edu), Department of Mathematics and Statistics, Bowling Green State University, Bowling Green, OH 43403. *Some examples of quasiisometries of nilpotent Lie groups.*

For every simply connected nilpotent Lie group, we construct self quasiisometries of the group that are at infinite distance from all the automorphisms. (Received August 27, 2012)

1084-20-119 **Jeffrey M Riedl*** (riedl@uakron.edu), Department of Mathematics, 302 Buchtel Common, University of Akron, Akron, OH 44325-4002, and **Daniel N Raies** (danraies@gmail.com). *Multiplicities of faithful irreducible character degrees of subgroups of wreath product p-groups.* Preliminary report.

Let p be an odd prime, let Z_p denote the cyclic group of order p, and let P denote the iterated regular wreath product group $Z_p \wr Z_p \wr Z_p$, which has an obvious normal subgroup B that is an elementary abelian p-group of rank p^2. We have developed an algorithm for calculating the number of faithful irreducible ordinary characters of each degree for certain well-behaved subgroups of P. This algorithm is computationally practical when the prime p is small. We have successfully implemented this algorithm in the cases $p = 3$ and $p = 5$ for a particular collection of subgroups of P which we denote by H_{jk}, where the indices j and k are integers ranging over $0 \leq j < p^2 - p$ and $0 \leq k < p$. We mention that H_{jk} splits over its abelian normal subgroup $B \cap H_{jk}$, and that the indices j and k correspond to the facts that $|B : B \cap H_{jk}| = p^j$ and $|H_{jk} : B \cap H_{jk} = p^{p-1-k}$. In the case $p = 5$ our implementation involved the creation of an extensive and elaborate computer program. In this talk we present the data that we have obtained using our algorithm, namely the number of faithful irreducible characters of every degree for each of the subgroups H_{jk} in the cases $p = 3$ and $p = 5$. (Received August 27, 2012)

1084-20-122 **John Maginnis** and **Silvia Onofrei*** (onofrei@math.ohio-state.edu), Department of Mathematics, The Ohio State University, 100 Math Tower, 231 W 18th Ave., Columbus, OH 43210. *The complex of p-centric and p-radical subgroups and its reduced Lefschetz module.*

We study the reduced Lefschetz module of the complex of p-centric and p-radical subgroups. We assume that the underlying group G has parabolic characteristic p and the centralizer of a certain noncentral p-element has a component with central quotient H, a finite group of Lie type in characteristic p. A nonprojective indecomposable summand of the associated Lefschetz module lies in a nonprincipal block of kG and it is a Green correspondent of an inflated, extended Steinberg module for a Lie subgroup of H. The vertex of this summand is the defect group of the block in which it lies. The application of these results to sporadic finite simple groups yields nine groups when p=2 and eight groups when p=3 for which the reduced Lefschetz module has precisely one nonprojective summand. (Received August 27, 2012)

1084-20-141 **Peter V Hegarty*** (hegarty@chalmers.se), Matematiska Vetenskaper, Chalmers University of Technology, Chalmers Tvargata 3, 41296 Gothenburg, Sweden. *Commuting graphs of finite groups.*

The following problem comes from group theory. If G is a group, the commuting graph of G has as its vertices the non-central elements of G and there is an edge between any pair of elements that commute. The concept has been known for over half a century and been studied in a number of contexts. Six years ago, two Iranian mathematicians made the intriguing conjecture that there is an absolute constant $C > 0$ such that, if G is a finite group whose commuting graph is connected, then the diameter of the latter cannot exceed C. The conjecture has attracted considerable attention amongst group theorists, and been verified for a variety of (mostly insolvable) groups. In particular, the largest previously known diameter is 6. Here we will present a family of finite groups which we counter-conjecture to contain examples where the diameter becomes arbitrarily large. The groups in this family are nilpotent of class 2, with both Z(G) and G/Z(G) of exponent 2, hence the analysis of their commuting graphs is an "additive problem". A probabilistic method is involved, which thus far provides a clear heuristic, though not a proof, for why arbitrarily large diameters should appear. Simulations have yielded groups where the diameter can attain any value up to 10. Joint work with Dmitry Zhelezov. (Received August 29, 2012)

1084-20-145 **James B. Wilson*** (jwilson@math.colostate.edu), 101 Weber Building, Fort Collins, CO 80523. *New characteristic subgroups.*

Recently Glasby-Palfy-Schneider characterized p-groups with exactly one proper nontrivial characteristic subgroup, concluding that there are not many. On the other hand, the class of special groups are bountiful (as proved by Higman) yet in general these groups have exactly one *known* proper nontrivial characteristic subgroup. This talk introduces some new characteristic subgroups for p-groups which occur nontrivially in many of the special groups. (Received August 29, 2012)

1084-20-180 **Michael Aaron Geline*** (geline@math.niu.edu), Northern Illinois University, Department of Mathematics, Watson Hall, DeKalb, IL 60115. *The Brauer Feit bound on irreducible character heights via Knörr lattices.* Preliminary report.

If p^a is the largest power of p dividing the order of the group G, and χ lies in a p-block with defect $d \geq 2$, Brauer and Feit showed that the height of χ is at most $d - 2$. Assuming an elementary abelian defect group, we will give a new proof of this using the theory of vertices and sources, specifically Knörr lattices. (Received August 31, 2012)

1084-20-182 **Sara Jensen*** (jensen@math.wisc.edu). *On the Character Degree Simplicial Complex of a Finite Solvable Group.* Preliminary report.

The character degree simplicial complex of a finite group G has as its simplices all subsets X of $\mathrm{cd}(G) \setminus \{1\}$ satisfying $\gcd(X) > 1$. The 1-skeleton of this simplicial complex is the character degree graph of the associated group G. Historically, much has been said about what types of graphs may appear as the character degree graphs of finite groups, and similarly, much can be said about the structure of a finite group given that it has a particular graph as its associated character degree graph.

One important topological aspect of the character degree simplicial complex is its dimension, which is one less than the size of the largest simplex. Suppose that G is a finite solvable group of dimension n. Benjamin was able to obtain a quadratic bound on $|\mathrm{cd}(G)|$ in terms of n. We obtain a quadratic bound on the rank of the fundamental group of the character degree simplicial complex of G in terms of n. Although Benjamin's result implies a bound on the rank of the fundamental group of the character degree simplicial complex in terms of the

dimension, the bound we obtain is much stronger. Additionally, our bound is independent of Benjamin's work. (Received August 31, 2012)

1084-20-184 **Jonathan I Hall*** (jhall@math.msu.edu). *Algebras from geometries and groups.*
In 1913 Study discussed the triality properties of hyperbolic 8-space. In 1925 Cartan discussed this geometric triality in the context of the automorphism groups of Lie groups of type D_4 and noted a connection with the Cayley-Graves octonions. In 1935 Moufang further connected alternative algebras with projective planes possessing many elations. We will discuss these and more general concepts of triality along with other situations where algebras are presented or explained by geometries and groups. (Received August 31, 2012)

1084-20-199 **Hung Ngoc Nguyen*** (hungnguyen@uakron.edu), Department of Mathematics, The University of Akron, Akron, OH 44325. *Class sizes and their multiplicities in finite simple groups.*
We prove that if S is a finite simple group then the order of S is bounded in terms of the largest multiplicity of its conjugacy class sizes. We then apply this result to prove that if the largest multiplicity of conjugacy class sizes of every quotient of a finite group G is m, then the order of G is bounded in terms of m. We also discuss some related open questions. (Received September 01, 2012)

1084-20-222 **Justin Lynd*** (jlynd@math.rutgers.edu). *The Thompson transfer lemma for fusion systems.*
The transfer map in finite group theory is a classical tool for identifying abelian quotients. The case of transfer from a Sylow p-subgroup S of a finite group G is completely determined by p-fusion in S (i.e. the G-conjugacy of subgroups in S) via the focal subgroup theorem. A saturated fusion system $\mathcal{F}$ is a category with objects the subgroups of a fixed finite p-group S, and with morphisms which serve to model the p-fusion in a finite group with Sylow p-subgroup S. Although the structure theory of fusion systems parallels that of finite groups, the construction of the transfer map in fusion systems is delicate and depends on the existence of a certain S-S biset associated to the fusion system $\mathcal{F}$.

The Classification of Finite Simple Groups makes use of transfer primarily in two forms: Yoshida's transfer theorem and the Thompson transfer lemma. This talk will be an account of a generalization of the latter result and its extensions by Harada, Goldschmidt, and Lyons over the years, proved in the setting of saturated fusion systems. This generalization is a key ingredient in the speaker's Ph.D. thesis, where certain fusion systems (at the prime 2) containing an involution centralizer of a specified type are classified. (Received September 02, 2012)

1084-20-267 **Bhama Srinivasan**, Department of Math, Stat, and Comp Sci, University of Illiinois at Chicago, 851 South Morgan Street, Chicago, IL 60607, and **C. Ryan Vinroot*** (vinroot@math.wm.edu), Department of Mathematics, College of William and Mary, P. O. Box 8795, Williamsburg, VA 23187. *Jordan decomposition and real-valued characters.* Preliminary report.
Let $\mathbf{G}$ be a connected reductive group defined over a finite field $\mathbb{F}_q$ by Frobenius map F, and let $G = \mathbf{G}^F$. The Jordan decomposition of characters gives a correspondence, with certain invariance properties with respect to Deligne-Lusztig induction, between irreducible characters of G, and pairs (s, ψ), where (s) is a semisimple class in the dual group G^*, and ψ is a unipotent character of $C_{G^*}(s)$, the centralizer of s in G^*. If s is a real element of G^*, suppose $h \in G^*$ such that $hsh^{-1} = s^{-1}$. Then the character ${}^h\psi$, ψ composed with conjugation by h, is also a unipotent character of G^*. We conjecture that the irreducible character of G corresponding to the pair (s, ψ) is real-valued if and only if s is a real element, and ${}^h\psi = \bar{\psi}$, where $hsh^{-1} = s^{-1}$. We give a proof of this in the case that $\mathbf{G}$ has connected center, and the centralizer $C_{G^*}(s)$ is a Levi subgroup of G^*. (Received September 03, 2012)

1084-20-332 **Sinead Lyle** and **Oliver Ruff*** (oruff@kent.edu). *Weight 2 Blocks of Ariki-Koike Algebras.* Preliminary report.
The Ariki-Koike algebra $\mathcal{H}_{n,r}$ is a deformation of the group algebra of the complex reflection group $G(r, 1, n)$; the Hecke algebras of types A and B occur as special cases when $r = 1$ and $r = 2$ respectively. Since $\mathcal{H}_{n,r}$ is cellular, there is a natural theory of Specht modules (labelled here by multipartitions of n into r parts), some of whose irreducible cosocles yield a complete collection of simple modules. The multipartitions that label the simple modules are said to be *Kleshchev*. An important problem in the representation theory of such algebras is to find the decomposition numbers: that is, the multiplicity with which each simple module occurs in a given Specht module.

The notion of *weight* for partitions has been extended to multipartitions by Fayers; it provides an invariant that measures the complexity of a block of $\mathcal{H}_{n,r}$. Weight 2 blocks of Hecke algebras of type A and type B have been described by Richards and Fayers respectively. In this talk we consider weight 2 blocks of $\mathcal{H}_{n,r}$ for arbitrary r – classifying the Kleshchev multipartitions, computing the decomposition numbers, and discussing generalizations to blocks of higher weight. (Received September 04, 2012)

1084-20-339 **Thomas Michael Keller*** (tk04@txstate.edu), Department of Mathematics, Texas State University, 601 University Drive, San Marcos, TX 78666, and **Yong Yang** (yangy@uwp.edu), Department of Mathematics, University of Wisconsin-Parkside, 900 Wood Road, Kenosha, WI 53141. *Bounds for abelian quotients of linear groups.*

In 1989 Aschbacher and Guralnick proved that if G is a finite group and V is a finite faithful G-module over a field of characteristic p such that $O_p(G) = 1$, then $|G/G'| < |V|$. We present a stronger bound under stronger hypotheses as follows. Let G be a finite solvable group and V a finite faithful completely reducible G-module, possibly of mixed characteristic. Let M be the largest orbit size in the action of G on V. Then $|G/G'| \leq M$. We conjecture that this result is also true under the weaker hypotheses of the Aschbacher-Guralnick result. (Received September 04, 2012)

1084-20-359 **Khalid Mohammed Bou-Rabee*** (khalid.math@gmail.com), **Ian Biringer**, **Martin Kassabov** and **Francesco Matucci**. *Intersection growth on groups.*

Intersection growth concerns the asymptotic behavior of the index of the intersection of all subgroups of a group that have index at most n. We motivate studying this growth and explore some examples with a focus on nilpotent groups and zeta functions. This covers joint work with Ian Biringer, Martin Kassabov, and Francesco Matucci. (Received September 04, 2012)

1084-20-362 **Amanda Taylor*** (taylor@math.binghamton.edu). *Locally Solvable Subgroups of PLo(I).*

A locally solvable group is a group in which every finitely generated subgroup is solvable. We introduce a geometric criterion that is equivalent to local solvability in PLo(I) and discuss a proof that locally solvable subgroups of PLo(I) are countable. Classification of these subgroups is the subject of the author's thesis. All these results hold for Thompson's Group F, too. (Received September 04, 2012)

1084-20-365 **Chris Hruska*** (chruska@uwm.edu), Department of Mathematical Sciences, University of Wisconsin-Milwaukee, PO Box 413, Milwaukee, WI 53201-0413, and **Kim Ruane**. *Local topology of boundaries for CAT(0) spaces with isolated flats.*

We study CAT(0) spaces with isolated flats and the local topology of the boundary at infinity (with the visual topology). In particular, we prove a theorem characterizing exactly when the boundary is locally connected.

This theorem extends Swarup's result that the boundary of every hyperbolic group is locally connected. We illustrate our theorem with an example of a one-ended CAT(0) group with isolated flats whose boundary is not locally connected. We also prove that every group acting properly and cocompactly on a CAT(0) space with isolated flats is semistable at infinity. (Received September 04, 2012)

26 ► Real functions

1084-26-147 **Krzysztof Chris Ciesielski*** (kcies@math.whu.edu), Department of Mathematics, West Virginia University, Morgantown, WV 26506-6310. *On functions on $\mathbb{R}^n$ continuous when restricted to nice curves or surfaces.*

A function from $\mathbb{R}^n$ into $\mathbb{R}$ is separately continuous, when its restriction to any line parallel to a coordinate axis is continuous. In this talk we will discuss the following generalizations of this notion—the classes of functions $f\colon \mathbb{R}^n \to \mathbb{R}$ with continuous restrictions to: (1) any line (i.e., linearly continuous functions), (2) any proper hyperplane (hyperplane continuous functions), and (3) any isometric copy of a graph of a k-times differentiable function (D^k-continuous functions). In particular, we will report a progress on a problem of characterization of the set of points of discontinuity of linearly continuous functions. We present an elementary example of discontinuous hyperplane continuous function on $\mathbb{R}^n$ for arbitrary n. We also describe an example of D^2-continuous function on $\mathbb{R}^2$ with the set of points of discontinuity having a positive one-dimensional Hausdorff measure. (Received August 29, 2012)

1084-26-295 **Volodymyr K. Maslyuchenko*** (math.analysis.chnu@gmail.com), Chernivtsi, 58000, Ukraine. *On approximation of separately continuous functions.* Preliminary report.

The investigations started with the seminal result of A. Lebesgue. He has showed that every separately continuous function on $\mathbb{R}^2$ belongs to the first Baire class. This result has been developing in two directions. The first one concerns point-wise approximation of separately continuous mappings by jointly continuous mappings. Research in this direction were made by H. Hahn, W. Moran, B. Johnson, J. Saint-Raymond, W. Rudin, G. Vera, V. Maslyuchenko, V. Mykhaylyuk, O. Sobchuk, T. Banakh, O. Maslyuchenko, O. Karlova and others. The second direction was started by M. Tsuji and is devoted to the question of the section-wise uniform approximation of separately continuous functions by means of different aggregates. The result of Tsuji was developed in the last years by V. Maslyuchenko, H. Voloshyn, O. Maslyuchenko and O. Nesterenko. We present these results which use Bernstein's, Fejér's and Jackson's operators, introduce a natural topology of section-wise uniform convergence on the space of separately continuous mappings on $[0,1]^2$, and study the sequential closure of the set of all polynomials. (Received September 04, 2012)

28 ► Measure and integration

1084-28-45 **Joseph Max Rosenblatt*** (rosnbltt@illinois.edu), Department of Mathematics, University of Illinois, Urbana, IL 61801. *Multivariable Differentiation in Euclidean Spaces.* Preliminary report.

Suppose we consider all rectangles $R = [0, l_1] \times \cdots \times [0, l_d]$ where $0 < l_1, \ldots, l_d \leq 1$. Let f_R^* be the maximal function corresponding to the Lebesgue derivatives $f_R = \frac{1}{|R|} 1_R * f$. It is a classical fact that this maximal function is strong (p, p) for $1 < p \leq \infty$ but is not weak $(1, 1)$. Also, the biggest Orlicz class that it is well behaved on is $L \log^{d-1} L$. It is also a classical fact that if $f_R^{\#}$ is the maximal function over rectangles that are restricted to having the lengths l_k all equal, then there is a weak $(1, 1)$ inequality. We consider various other ways to restrict the set of lengths $(l_1, \ldots, l_d)$ being used. We seek to characterize when the associated restricted maximal function satisfies a weak $(1, 1)$ inequality. If this fails to be the case, we seek to characterize the optimal Orlicz class on which the restricted maximal function is well-behaved. (Received August 13, 2012)

1084-28-266 **Steven Michael Senger*** (senger@math.udel.edu), Department of Mathematical Sciences, University of Delaware, Newark, DE 19716-2553. *New estimates on Erdős-Falconer type single distance problems.*

We discuss the Erdős-Falconer type single distance problems, and present new estimates on the measure of the set of pairs of points from a subset of $[0, 1]^d$ which are ϵ-nearly a given distance apart. (Received September 03, 2012)

30 ► Functions of a complex variable

1084-30-38 **Pamela Gorkin*** (pgorkin@bucknell.edu), **Sandra Pott** and **Brett D. Wick**. *What is a thin interpolating sequence?* Preliminary report.

Interpolating Blaschke sequences play an important role in the study of complex function theory in the disk. In this talk, we look at the role played by a smaller class of sequences–the thin interpolating sequences. We'll discuss these sequences from different angles: a model space perspective, an H^p perspective (for $1 \leq p \leq \infty$) and a uniform algebra perspective. (Received August 11, 2012)

31 ► Potential theory

1084-31-340 **Mykhailo Bilogliadov*** (mbilogli@math.okstate.edu), Department of Mathematics, Oklahoma State University, Stillwater, OK 74078. *THE EQUILIBRIUM POINTS OF A FIELD OF POINT CHARGES AT THE VERTICES OF A REGULAR POLYGON.* Preliminary report.

We will be considering a field generated by a system of point charges placed at the vertices of a regular polygon. Using the symmetries of a regular polygon we derive an integral representation of a potential of the system under consideration. Then using an integral representation of the potential we prove a theorem on a number of equilibrium points of that system. The result obtained in this work gives a partial answer for a conjecture by J.

C. Maxwell on the maximal number of equilibrium points of a system comprised by point charges. (Received September 04, 2012)

32 ► Several complex variables and analytic spaces

1084-32-8 **Mishko Mitkovski** (mishko@math.gatech.edu), School of Mathematics, Georgia Institute of Technology, 686 Cherry Street, Atlanta, GA 30332-1060, **Daniel Suarez** (dsuarez@dm.uba.ar), Depto. de Matemática, FCEyN, University of Buenos Aires, Pab. I, Ciudad Universitaria, Buenos Aires, Argentina, and **Brett D. Wick*** (wick@math.gatech.edu), School of Mathematics, Georgia Institute of Technology, 686 Cherry Street, Atlanta, GA 30332-0160. *The Essential Norm of Operators on the Bergman Space.*

We characterize the compact operators on $A^p_\alpha(\mathbb{B}_n)$ when $1 < p < \infty$ and $\alpha > -1$. The main result shows that an operator on $A^p_\alpha(\mathbb{B}_n)$ is compact if and only if its Berezin transform vanishes on the boundary of the ball and additionally this operator belongs to the Toeplitz algebra $\mathcal{T}_{p,\alpha}$. (Received June 20, 2012)

1084-32-22 **John P. D'Angelo***, Dept. of Mathematics, Univ. of Illinois, 1409 W. Green St., Urbana, IL 61801. *An easy L^2 estimate and volume computation.*

The $2n$-dimensional volume of the image of the unit ball under a holomorphic mapping is the sum of the squared L^2 norms of the Jacobians of each n-tuple of component functions. We prove a monotonicity result for such volumes under a tensor product operation. We derive from it a sharp bound for the volume of the image of the unit ball under a proper polynomial mapping of given degree d. This bound is achieved by the map $z \to z^{\otimes d}$. (Received July 27, 2012)

1084-32-63 **Kenneth D Koenig***, Department of Mathematics, Ohio State University, Columbus, OH 43210. *Maximal hypoellipticity for the $\overline{\partial}$-Neumann problem.*

We establish maximal hypoellipticity (in L^p-Sobolev and Lipschitz norms) for the $\overline{\partial}$-Neumann problem on smooth, bounded pseudoconvex domains in $\mathbb{C}^n$ under the weakest possible condition on the Levi form. In particular, maximal hypoellipticity holds on the level of $(n-1)$-forms for all smooth, bounded pseudoconvex domains of finite commutator type. These results are new in dimensions $n \geq 3$. (Received August 18, 2012)

1084-32-75 **R. Michael Range*** (range@math.albany.edu), Department of Mathematics and Statistics, State University of New York at Albany, Albany, NY 12222. *A New Integral Kernel for Weakly Pseudoconvex Domains.*

Given an arbitrary weakly pseudoconvex domain D in $\mathbb{C}^n$ with smooth boundary bD, a suitable local modification of the Levi polynomial of a particular defining function is introduced to obtain a new Cauchy-Fantappié kernel on $bD \times D$. While the new kernel is not holomorphic in the parameter $z \in D$, it does reflect the complex geometry and the Levi form of the boundary. Some estimates for the corresponding integral operator are discussed which show that the new kernel has better properties than the standard Bochner-Martinelli kernel. Consequently this kernel and its corresponding extensions to (p,q)-forms should provide useful new tools for complex analysis in this general setting. In particular, this leads to a ***pointwise*** *basic estimate in the theory of the $\overline{\partial}$-Neumann problem on weakly pseudoconvex domains which is an analogon of the Kohn-Morrey basic estimate in the L^2 theory.* (Received August 22, 2012)

1084-32-92 **Tamas Darvas**, tdarvas@math.purdue.edu, and **Laszlo Lempert***, lempert@purdue.edu. *Geodesics in the space of Kahler metrics.*

Given a compact Kähler manifold, according to Mabuchi, the set of Kähler forms in a fixed cohomology class has the natural structure of an infinite dimensional Riemannian manifold. We address the question whether points in this Riemannian manifold can be joined by a geodesic, and strengthening earlier findings of Liz Vivas and the second author here, we show that this cannot always be done even with a certain type of generalized geodesics. As in the work with Vivas, the result is obtained through the analysis of a Monge–Ampère equation. (Received August 24, 2012)

1084-32-115 **David E Barrett*** (barrett@umich.edu). *$\mathbb{T}^2$-invariant Fefferman-Plateau problems in $\mathbb{C}^2$.* Preliminary report.

A complex-analytic version of the Plateau problem asks for the construction of real hypersurfaces of vanishing Webster curvature with prescribed Dirichlet and Neumann boundary data The problem is invariant under constant-Jacobian biholomorphic mapping, and is motivated in part by a result of Hammond to the effect that

the vanishing of Webster curvature is the Euler-Lagrange condition characterizing critical points of Fefferman's hypersurface measure subject to the indicated boundary conditions.

In this talk we consider the $\mathbb{T}^2$-invariant ("Reinhardt") version of this problem with attention to the following issues:

- existence and uniqueness of solutions;
- to what extent is it true that solutions maximize Fefferman measure?

The talk will make use of work done by Aviva Siegel as part of her 2012 REU project. (Received August 27, 2012)

1084-32-131 **Yunus E Zeytuncu*** (zeytuncu@math.tamu.edu), TAMU Mailstop 3368, College Station, TX 77843. *Compactness of the $\bar{\partial}$-Neumann operator and the Nebenhülle of Hartogs domains.*

Let $\mathbb{D}$ denote the unit disk in $\mathbb{C}$ and let $\phi(z)$ be a bounded subharmonic function on $\mathbb{D}$. We consider the pseudoconvex complete Hartogs domains in $\mathbb{C}^2$ of the form

$$\Omega = \{(z, w) \in \mathbb{C}^2 : \ z \in \mathbb{D} \text{ and } |w| < e^{-\phi(z)}\}.$$

Let N_1 denote the $\bar{\partial}$-Neumann operator on $L^2_{(0,1)}(\Omega)$. In this talk, we relate the regularity properties of N_1 and the Nebenhülle of Ω. (Received August 28, 2012)

1084-32-133 **Dusty E Grundmeier*** (grundmer@umich.edu), Department of Mathematics, 2074 East Hall, 530 Church Street, Ann Arbor, MI 48109-1043. *Chebyshev Polynomials and CR Mappings.* Preliminary report.

In the study of group-invariant CR maps between spheres, one is naturally led to a family of polynomial maps that are closely related to the Chebyshev polynomials. In this talk I will make this connection precise and explore what number-theoretic and combinatorial properties of Chebyshev polynomials extend to this broader context. (Received August 28, 2012)

1084-32-134 **Muhammed A ALAN*** (malan@syr.edu), 215 Carnegie Building, Syracuse University, Syracuse, 13244, and **Nihat G Gogus** (nggogus@sabanciuniv.edu), Sabanci University, Orhanli, Tuzla, 34956 Istanbul, Turkey. *Supports of Weighted Equilibrium Measures: Complete Characterization.* Preliminary report.

Determining the supports of weighted extremal measures is important in pluripotential theory and approximation theory. In one complex variable, it is known that a compact set K is the support of the Laplacian of a logarithmic potential with an external field if and only if K is nonpolar at any point. In this talk, we prove that a compact set K is the support of the Monge-Ampère measure of a weighted extremal function if and only if K is nonpluripolar at any point. At the end we will present some related open problems. (Received August 28, 2012)

1084-32-172 **Emil J. Straube*** (straube@math.tamu.edu) and **Yunus E. Zeytuncu** (zeytuncu@math.tamu.edu). *Sobolev estimates for the complex Green operator on CR-submanifolds of hypersurface type.* Preliminary report.

The "vector field method" for proving Sobolev estimates for the $\overline{\partial}$-Neumann operator on bounded pseudoconvex domains can be adapted relatively easily to prove Sobolev estimates for the complex Green operator on pseudoconvex CR-submanifolds of hypersurface type. The question then arises on which such manifolds the required (families of) vector fields exist. (Received August 31, 2012)

1084-32-269 **Samangi Munasinghe***, Department of Mathematics, Western Kentucky University, 1906 College Heights Blvd., Bowling Green, KY 42102. *Compactness of the $\overline{\partial}$-Neumann operator on block diagonal domains.*

We give sufficient conditions for compactness of the $\overline{\partial}$-Neumann operator for a specific class of domains. The block diagonal domains were introduced by M. Derridj and the geometric sufficient conditions were introduced by E. Straube. (Received September 03, 2012)

1084-32-298 **John T Anderson*** (anderson@mathcs.holycross.edu), Dept. of Mathematics and Computer Science, College of the Holy Cross, Worcester, MA 01610-2395, and **Alexander Izzo** (aizzo@math.bgsu.edu). *Approximation on Real-Analytic Varieties.*

Let V be a real-analytic variety in $\mathbb{R}^n$, K a compact subset of V, and A a uniform algebra generated by functions real-analytic in a neighborhood of K. Assuming (1) every point of K is a peak point for A, and (2) the maximal ideal space of A is K, we show that $A = C(K)$. This generalizes previous results of the authors and John Wermer

concerning approximation by holomorphic polynomials on real-analytic varieties in $\mathbb{C}^n$. (Received September 04, 2012)

1084-32-299 **Steve Zelditch*** (zelditch@math.northwestern.edu), Evanston, IL 60208, and **Yanir Rubinstein**. *The Cauchy problem for the homogeneous complex Monge Ampere equation.*
The Cauchy problem for the HCMA (complex homogeneous Monge Ampere equation) is the initial value problem for geodesics in the space of Kahler metrics in a fixed class. I will define the lifespan of the solution in various regularity classes and explain that for many initial data there does not exist a solution with a positive lifespan. (Received September 04, 2012)

1084-32-356 **Bernard Shiffman***, shiffman@math.jhu.edu. *Level sets of random holomorphic sections.*
We discuss the distribution of values of the Euler characteristic of level sets of Gaussian random holomorphic sections of powers of a positive line bundle L over a compact Kähler manifold M. Our methods involve the off-diagonal scaling asymptotics of the Szegő kernels for the spaces $H^0(M, L^N)$ of holomorphic sections of L^N. We also apply these methods to the distribution of values of the sup-norms of random sections. (Received September 04, 2012)

34 ► Ordinary differential equations

1084-34-67 **Anna R Ghazaryan***, ghazarar@muohio.edu, and **Stephen Schecter** and **Peter Simon**. *Fronts in a model for gasless combustion with heat loss.*
We consider a model of gasless combustion with heat loss, with the heat loss from the system to the environment modeled according to Newton's law of cooling. For the regime when the system contains two small parameters, a diffusion coefficient for the fuel and a heat loss parameter, we use geometric singular perturbation theory to show existence of traveling combustion fronts. We also study their spectral and nonlinear stability. (Received August 20, 2012)

1084-34-158 **Roger Nichols*** (roger-nichols@utc.edu). *Positivity Preserving of Semigroups and Resolvents of Sturm–Liouville-type Operators with Distributional Coefficients.* Preliminary report.
In this talk, we consider self-adjoint extensions of the minimal operator associated with Sturm–Liouville-type differential expressions,

$$\tau f = \frac{1}{r}\big(- \big(p[f' + sf]\big)' + sp[f' + sf] + qf\big) \text{ on } (a, b) \subset \mathbb{R},$$

where the coefficients p, q, r, s are real-valued and Lebesgue measurable on (a, b), with $p \neq 0$, $r > 0$ a.e. on (a, b), and p^{-1}, q, r, $s \in L^1_{\text{loc}}((a, b); dx)$, and f belongs to a suitably wide class of functions. In the case where τ is regular on (a, b) (i.e., when (a, b) is a finite interval and $L^1_{\text{loc}}((a, b); dx)$ above may be replaced by $L^1((a, b); dx)$), all self-adjoint extensions of the minimal operator are characterized by boundary conditions at a and b. Using integral operator techniques and the Beurling–Deny criterion, under the assumption $p > 0$ a.e. on (a, b), we classify all boundary conditions leading to self-adjoint extensions which generate a positivity preserving semigroup (equivalently, resolvent).

This talk is based on joint work with Jonathan Eckhardt (Vienna), Fritz Gesztesy (Missouri) and Gerald Teschl (Vienna, ESI). (Received August 30, 2012)

1084-34-260 **Weishi Liu*** (wliu@math.ku.edu), 1460 Jayhawk Blvd., 405 Snow Hall, Lawrence, KS 66045. *Ion size effects for ionic flows through ion channels.* Preliminary report.
It is well-known that ion sizes have significant impacts on many important biological functions of living organisms. We will discuss recent progresses on our study of Poisson-Nernst-Planck type models taking into consideration of ion sizes for ionic flows through ion channels. In these models, ions are treated as charged hard-spheres rather than point-charges. Simple (microscopic) models of both local and nonlocal versions for hard-spheres will be treated. The (macroscopic) effect of ion sizes on I-V (current-voltage) relations will be examined.

This talk is based on joint works with S. Ji (Jilin University), G. Lin (Renmin University of China), X. Tu (KU), M. Zhang (KU), and Y. Yi (Georgia Tech). (Received September 03, 2012)

1084-34-350 **Vahagn Manukian*** (manukive@muohio.edu), Miami University Hamilton, 1601 University Blvd, Hamilton, OH 45011. *Global analysis of a planar vector field.*

We analyze a nonlinear planar system with three parameters near a normal form with nilpotent singularity that captures the bifurcation structure of the vector field generated by the equations of chemical kinetics of the Gray-Scott model. (Received September 04, 2012)

35 ► Partial differential equations

1084-35-1 **T. J. Christiansen*** (christiansent@missouri.edu), Department of Mathematics, University of Missouri, Columbia, MO 65211. *Resonances and Schrödinger operators.*

Physically, *resonances* may correspond to decaying waves, in contrast to eigenvalues, which correspond to periodic waves in many models. Mathematically, much less is known about the behavior of resonances than that of eigenvalues of a self-adjoint operator.

We give an introduction to resonances, concentrating on the case of the Schrödinger operator on $\mathbb{R}^d$. We discuss a number of questions related to the distribution of resonances. Among other things, we show how the use of complex-valued potentials can help prove results about resonances of Schrödinger operators with real-valued potentials. (Received August 10, 2012)

1084-35-6 **Kazuo Yamazaki*** (kyamazaki@math.okstate.edu), Department of Mathematics, Oklahoma State University, 401 Mathematical, Sciences, Stillwater, OK 74078. *Regularity criteria of supercritical quasi-geostrophic equation in terms of partial derivatives.*

The global regularity issue of the two-dimensional surface quasi-geostrophic equation, in particular in the supercritical case, has caught much attention from many mathematicians recently.

We obtain new regularity criteria and smallness condition for the global regularity of the solution to the beta-generalized surface quasi-geostrophic equation. In particular, it is shown that in order to obtain global regularity results, one only needs to bound its partial derivative. Results may be generalized to similar active scalars, e.g. the three-dimensional porous media equation. (Received August 22, 2012)

1084-35-15 **Li Yang*** (yangli3@msu.edu), A212 Wells Hall, Math Dept of Michigan State University, East Lansing, MI 48824, and **Keith Promislow** (kpromisl@math.msu.edu), Math Dept of MSU, East Lansing, MI 48824. *Existence of Homoclinic Solutions of The Functionalized Cahn-Hilliard Energy.*

We introduce the functionalized Cahn-Hilliard (FCH) energy, a negative multiple of the Cahn-Hilliard energy balanced against the square of its own variational derivative, as a finite width regularization of the sharp-interface Canham-Helfrich energy. We show the existence of the homoclinic solutions for the functionalized Cahn-Hilliard Energy by two methods, functional analytical method and Lin's method. (Received July 06, 2012)

1084-35-21 **Stephane Lafortune*** (lafortunes@cofc.edu), Department of Mathematics, College of Charleston, Charleston, SC 29401, and **Andrew Hone**, University of Kent. *Stability of solutions for nonintegrable peakon equations.*

The Camassa-Holm equation with linear dispersion was originally derived as an asymptotic equation in shallow water wave theory. Among its many interesting mathematical properties, which include complete integrability, perhaps the most striking is the fact that in the case where linear dispersion is absent it admits weak multi-soliton solutions - "peakons" - with a peaked shape corresponding to a discontinuous first derivative. There is a one-parameter family of generalized Camassa-Holm equations, most of which are not integrable, but which all admit peakon solutions. Numerical studies reported by Holm and Staley indicated changes in the stability of these and other solutions as the parameter varies through the family. In this presentation, I describe analytical results on one of these bifurcation phenomena, showing that in a suitable parameter range there are stationary solutions which are orbitally stable. (Received July 18, 2012)

1084-35-29 **Yu Wang*** (yw2340@math.columbia.edu), 2990 Broadway, Room 509, MC 4406, New York, NY 10027. *On a $C^{2,\alpha}$-Estimate for the Complex Monge-Ampère Equation.*

We prove a $C^{2,\alpha}$-estimate for the solution u to the equation

$$\det(u_{\bar{k}j}) = f, \quad f^{1/n} \in C^{\alpha}, \quad f \geq \lambda$$

under the assumption that Δu is bounded from above. Our result settles one of the regularity problems arisen from a paper of Chen and Tian (2008). The proof is based on a reduction of the complex Monge-Ampère equation to a Bellman-type equation, to which the regularity theory of fully-nonlinear uniformly elliptic equations can be applied. (Received August 02, 2012)

1084-35-36 **Keith S Promislow*** (kpromisl@math.msu.edu), Dept. of Mathematics, Michigan State University, Okemos, MI 48864. *Competitive instabilities in Network Morphologies.*

A fundamental goal of polymer chemistry is to produce network structures of desired morphology. Typically the optimal structures occur at the smallest possible length scales, 5-50 angstroms, at which molecules can assemble, so as to maximize the surface area available for chemistry, and to maximize selective transport. At these length-scales solvent-ion interactions are dominant and ionic entropy, solvation shells and excluded volume effects must be accounted for. We present a reformulation of the Cahn-Hilliard energy, the Functionalized Cahn-Hilliard (FCH) energy, which dramatically extends its applicability. We show that the minimizers of the FCH correspond to the bilayer, pore, and micelle structures that are ubiquitous in these systems, moreover we investigate the competition between these structures that leads to the selection of stable morphologies. (Received August 11, 2012)

1084-35-39 **Dean Baskin*** (dbaskin@math.northwestern.edu), Department of Mathematics, Northwestern University, 2033 Sheridan Road, Evanston, IL 60208, and **Andras Vasy** and **Jared Wunsch**. *Asymptotics of radiation fields in asymptotically Minkowski spacetimes.*

Radiation fields are (appropriately rescaled) limits of solutions of wave equations along light rays. In this talk I will describe a class of (non-static) asymptotically Minkowski space times for which the radiation field is defined and indicate how methods of Vasy can be used to express the asymptotics in terms of the resonances of a related Riemannian problem on an asymptotically hyperbolic manifold. In particular, even on Minkowski space, these methods give a new understanding of the Klainerman-Sobolev estimates. This is joint work with Andras Vasy and Jared Wunsch. (Received August 11, 2012)

1084-35-49 **Yuri Latushkin*** (latushkiny@missouri.edu), 104 Mathematical Sciences Building, University of Missouri, Columbia, MO 65211, and **Valerian Yurov** (vayt37@mail.missouri.edu), 02 Mathematical Sciences Building, University of Missouri, Columbia, MO 65211. *Effective stability constants for semigroups with applications to Reaction-diffusion equations with degenerate diffusion matrix.*

For a strongly continuous operator semigroup $T(t)$ on a Banach space, we revisit a quantitative version of Datko's Theorem and establish the estimates on the constant M that satisfy the inequality $\|T(t)\| \leq Me^{\omega t}$ for all $t \geq 0$, in terms of the norm of convolution. This estimate is then used to establish a stability estimate for the linearization of a degenerate reaction-diffusion system at a travelling pulse or front. (Received August 14, 2012)

1084-35-65 **Thinh T Kieu*** (thinh.kieu@ttu.edu), 4306 16th Street, Quaker Pines Apt #5, Lubbock, TX 79416, **Akif Ibragimov** (akif.ibraguimov@ttu.edu), Department of Mathmatics and Statistics, Texa, Lubbock, TX 79409, and **Luan T Hoang** (luan.hoang@ttu.edu), Department of Mathmatics and Statistics, Texa, Lubbock, TX 79409. *Stability of solutions to generalized Forchheimer equations of any degree.*

The nonlinear Forchheimer equations are considered as laws of hydrodynamics in porous media in case of high Renolds numbers, when the fluid flows deviate from the ubiquitous Darcy's law. In this article, we study the generalized Forchheimer equations for slightly compressible fluids.

The bounds for their solutions are established in L^α-norm for all $\alpha \geq 1$. We prove that the solutions depend continuously on the boundary data on both at finite time and time infinity. The related long-time dynamics results obtained here are for general L^α-spaces.

New Poincaré-Sobolev inequalities and nonlinear Gronwall-type estimates for nonlinear differential inequalities are utilized to achieve better asymptotic bounds.
(Received September 04, 2012)

1084-35-80 **Joceline Lega*** (lega@math.arizona.edu). *Touchdowns in one and two dimensions.*

I will discuss the dynamics of a fourth order parabolic partial differential equation (PDE) with singular nonlinearity in one- and two-dimensional domains. This equation is a variant of a standard model for MEMS (MicroElectroMechanical Systems). Its solutions become singular in finite time and the main purpose of this study is to describe the touchdown set, which is the location of points in the domain where singularities occur.

In one dimensional domains, singularities occur on a discrete set of points, whose location may be predicted by means of asymptotic analysis. The one-dimensional theory may be used to determine the nature of the touchdown set in two dimensions; the result essentially depends on whether boundary layer deformations can interact constructively before the solution becomes singular in the rest of the domain. I will describe the theoretical framework we developed to understand the nature of the touchdown set and show numerical simulations of the PDE on various domains.

The one-dimensional work is joint with Alan Lindsay (University of Arizona and Heriot-Watt University) and the two-dimensional work is with Alan Lindsay and Francisco Sayas (University of Delaware). (Received August 23, 2012)

1084-35-93 **Peter V. Gordon*** (pgordon@uakron.edu), Department of Mathematics, The University of Akron, Akron, OH 44325. *Periodic solutions for fire-diffuse-fire model with nonlinear absorption.*

Calcium dynamics plays an important role in intracellular communication in living cells. The fire-diffuse-fire model, which accounts for the effects of diffusion, absorption, and localized release of calcium, has been successfully used to model the initiation, propagation and failure of calcium waves and other spatio-temporal patterning of intracellular calcium. Previous theoretical studies were usually performed under the assumption of a linear absorption mechanism. In this talk I will present a simple and robust method to construct various periodic solutions for arbitrary types of absorption for the one-dimensional fire-diffuse-fire model. I will then give examples of such periodic waves and discuss their stability. Finally, I will present numerical results showing that certain periodic solutions are robust in the sense that they are insensitive to the failure or delay of the localized release of calcium. This is a joint work with Louis Tao (Peking University). (Received August 24, 2012)

1084-35-116 **Mikhail Feldman** and **Adrian Tudorascu***, Dept. of Mathematics, WVU, Morgantown, WV 26506. *Weak Lagrangian solutions for the Semi-Geostrophic system in physical space.* Preliminary report.

Proposed as a simplification for the Boussinesq system in a special regime, the Semi-Geostrophic (SG) system is used by metereologists to model how fronts arise in large scale weather patterns. In spite of significant progress achieved in the analysis of the SG in dual space (i.e. the system obtained from the SG by a special change of variables), there are no existence results on the SG in physical space except in some very special cases. We shall argue that weak (Eulerian) solutions for the Semi-Geostrophic system in physical space exhibiting some mild regularity in time cannot yield point masses in the dual space. However, such solutions are physically relevant to the model. Thus, we shall discuss a natural generalization of Cullen & Feldman's weak Lagrangian solutions in the physical space to include the possibility of singular measures in dual space. We have proved existence of such solutions in the case of discrete measures in dual space. This is joint work with M. Feldman. (Received August 27, 2012)

1084-35-121 **Xiang Xu*** (xuxiang@andrew.cmu.edu), Carnegie Mellon University, Wean Hall 6113, Pittsburgh, PA 15213, and **Hao Wu**. *Global regularity and stability of a hydrodynamic system modeling vesicle and fluid interactions.*

In this paper, we study a hydrodynamical system modeling the deformation of vesicle membranes in incompressible viscous fluids. In the three dimensional case, we prove the existence/uniqueness of local strong solutions for arbitrary initial data as well as global strong solutions under the large viscosity assumption. We also establish some regularity criteria in terms of the velocity for local smooth solutions. Finally, we study the stability of the system near local minimizers of the elastic bending energy. (Received August 27, 2012)

1084-35-144 **Tao Huang*** (thuang@ms,uky.edu) and **Changyou Wang**. *Regularity and uniqueness of the heat flow of biharmonic maps.*

We first establish regularity of the heat flow of biharmonic maps into the unit sphere $\mathbb{S}^L \subset \mathbb{R}^{L+1}$ under a smallness condition of renormalized total energy. For the class of such solutions to the heat flow of biharmonic maps, we prove the properties of uniqueness, convexity of hessian energy, and unique limit at $t = \infty$. We establish both regularity and uniqueness for Serrin's (p, q)-solutions to the heat flow of biharmonic maps into any compact Riemannian manifold N without boundary. (Received August 29, 2012)

1084-35-149 **Lizheng Tao*** (ltao@math.okstate.edu), 401 MSCS O.S.U., stillwater, OK 74078. *Two Variations of the Boussinesq Equations.*

This talk will focus on the global regularity problem concerning some generalized versions of the Boussinesq system. The first generalization is an active scaler type with a logarithmically supercritical Fourier multiplier operator. The second one includes a more generalized supercritical dissipation in the velocity equation. The regularity is achieved by introducing a variation of the Besov space norm. We will show the conservation, which is global in time, of the L^q norm of both the vorticity and θ. The uniqueness of the solutions to these system is given at the end section. This is a joint work with Durga K.C., Dipendra Regmi and Jiahong Wu. (Received August 29, 2012)

1084-35-164 **Lei Zhang*** (leizhang@ufl.edu), Department of Mathematics, 358 Little Hall, P.O. Box 118105, Gainesville, FL 32611-8105, and **Jiguang Bao** and **Haigang Li**. *Monge Ampere Equations on exterior domains.*

We consider Monge-Ampère equations defined outside a convex set. First we show that all the convex viscosity solutions behave like parabolas near infinity. Then we solve exterior Dirichlet problem with given boundary data on the convex set and prescribed asymptotic behavior at infinity. This is a joint work with Jiguang Bao and Haigang Li. (Received September 04, 2012)

1084-35-174 **Allan Greenleaf*** (allan@math.rochester.edu), Department of Mathematics, University of Rochester, Rochester, NY 14618, and **Yaroslav Kurylev**, **Matti Lassas**, **Ulf Leonhardt** and **Gunther Uhlmann**. *Cloaked resonances for acoustic and quantum mechanical waves.*

Ideal transformation optics-based cloaks are sets of singular and anisotropic physical parameters that render an object undetectable to outside observation in both the near- and far-field. In most cases, the cloaking effect is accompanied by shielding, so that external waves do not intrude into the cloaked object. We describe sets of physical parameters (i.e., coefficients of either the Helmholtz or Schrödinger equation) which we call Schrödinger hats. These are obtained by augmenting approximate acoustic or quantum mechanical cloaks with certain parameters inside the cloaked region, giving rise to strong interior resonances. Possible applications include almost cloaked sensors. (Received August 31, 2012)

1084-35-175 **Cyrill B Muratov*** (muratov@njit.edu) and **Matteo Novaga**. *Front Propagation in Stratified Media: A Variational Approach.*

We prove, under generic assumptions, that the special variational traveling wave that minimizes the exponentially weighted Ginzburg-Landau functional associated with scalar reaction-diffusion equations in infinite cylinders is the long-time attractor for the solutions of the initial value problems with front-like initial data. The convergence to this traveling wave is exponentially fast. The obtained result is mainly a consequence of the gradient flow structure of the considered equation in the exponentially weighted spaces and does not depend on the precise details of the problem. It strengthens our earlier generic propagation and selection result for "pushed" fronts. (Received August 31, 2012)

1084-35-188 **Milena Stanislavova***, Department of Mathematics, University of Kansas, 405 Snow Hall, 1460 Jayhawk Blvd, Lawrence, KS 66045, and **Sevdzhan Hakkaev** and **Atanas Stefanov**. *Linear Stability for Traveling Pulses of the Boussinesq "ABC" System.*

We study rigorously and characterize the spectral stability of some explicit traveling waves of the "abc"-system in the regime $b > 0, a, c < 0$. This is achieved via the use of instabilities indices counting formulas of Kapitula, Kevrekidis and Sandstede and its refinement for the case of solitary waves by Kapitula and Stefanov. (Received August 31, 2012)

1084-35-189 **Peter Topalov*** (p.topalov@neu.edu). *Qualitative features of the periodic solutions of KdV.*

We discuss some new qualitative features of the solutions of the KdV equation on the circle. The main result states that the KdV solution map can be approximated in H^{N+1} uniformly on bounded sets of H^N, $N \geq 0$, by simple trigonometric expressions involving the KdV-frequencies.(This is a joint work with T. Kappeler and B. Schaad.) (Received August 31, 2012)

1084-35-197 **Luan Thach Hoang*** (luan.hoang@ttu.edu), Department of Mathematics and Statistics, Texas Tech University, Box 41042, Lubbock, TX 79409-1042, and **Akif Ibragimov**, **Thinh Tri Kieu** and **Zeev Sobol**. *Generalized Forchheimer equations for slightly compressible fluids.* Preliminary report.

We study generalized Forchheimer (non-Darcy) flows of slightly compressible fluids in porous media with time-dependent Dirichlet boundary data. The long time dynamics is studied in the general L^α spaces for all $\alpha \geq 1$. In addition to estimates of the solution for large time, we prove the structural stability with respect to the coefficients of the Forchheimer polynomials. In dealing with the weak diffusion of this degenerate parabolic equation, we utilize Sobolev-Poincaré type inequality for mixed terms and a non-linear Gronwall's inequality. The stability is established by using a perturbed monotonicity and carefully treating the cross-terms of the solutions and their derivatives. (Received September 01, 2012)

1084-35-207 **Emmanuele DiBenedetto** (em.diben@vanderbilt.edu), **Ugo Gianazza** (gianazza@imati.cnr.it) and **Naian Liao*** (naian.liao@vanderbilt.edu), 3209 West End Circle, Apt. 5, Nashville, TN 37203. *A Logarithmic Diffusion Equation as the Limit of Porous Medium Equations.*

Consider the logarithmic diffusion equation $u_t = \Delta \ln u$ which can be seen as a formal limit of the porous medium equations $u_t = \Delta \frac{u^m}{m}$ as $m \to 0$. Recently some authors made such a limit rigorous by prescribing initial or/and boundary data. However our approach is entirely local (joint work with E. DiBenedetto and U. Gianazza). Under the assumption that

$$\frac{u_m^m - 1}{m} \in L^p_{loc}, u_m \in L^r_{loc}$$

for some $p > N+2$ and $r > \frac{1}{2}N$ where u_m is the solution to $u_t = \frac{u^m}{m}$ and N is the space dimension, we establish a $C^{\alpha, \frac{\alpha}{2}}_{loc}$ limit process by finding the uniform upper bound and lower bound of solutions to the porous medium equations. The uniform lower bound is realized by a Harnack-type inequality. (Received September 01, 2012)

1084-35-237 **Shibin Dai*** (sdai@math.msu.edu), Department of Mathematics, Michigan State University, East Lansing, MI 48824, and **Keith Promislow**. *Functionalized Cahn-Hilliard equation: competitive evolution of bilayers and pores.*

The functionalized Cahn-Hilliard equation is introduced as a phase field model to describe the evolution of complex nanoscale structures similar to those observed in Polymer Electrolyte Membrane (PEM) fuel cells. Such complex structures include single layers, bilayers, pore networks and micelles, etc. We concentrate on the motion of closed bilayers and pores. Using asymptotic analysis, we analyze their inner structures and derive the leading order normal velocity in different time scales. Also we will show the mechanism under which they compete with each other. (Received September 03, 2012)

1084-35-241 **Annalisa Calini*** (acalini@nsf.gov), Division of Mathematical Sciences, National Science Foundation, Arlington, VA 22230. *Linear stability of closed vortex filaments.*

I will describe a framework for studying the linear stability of periodic solutions of the Vortex Filament Equation (VFE), based on the Hasimoto correspondence between the VFE and the Nonlinear Schrödinger (NLS) equation, and on the construction of solutions of the linearized equations in terms of NLS squared eigenfunctions. I will derive criteria for instability of closed vortex filaments associated with periodic traveling wave solutions of the NLS, and provide a characterization of the linear instabilities of filaments associated with cnoidal NLS potentials, concluding that all knotted filaments in this class are linearly unstable. This talk is based on joint work with Scott Keith and Stephane Lafortune. (Received September 03, 2012)

1084-35-247 **Hans Christianson*** (hans@math.unc.edu), CB #3250 Dept. of Mathematics, UNC, Chapel Hill, NC 27599. *High energy resolvent estimates on warped product spaces.*

This talk will discuss high frequency cutoff resolvent estimates on asymptotically Euclidean warped product manifolds with a certain Gevrey regularity. The main result is that, if the trapped set has only finitely many connected components, then the resolvent is either (almost) bounded or blows up faster than any polynomial. There are corresponding statements about non-existence or existence of resonances. The estimates are improved in the analytic category. (Received September 03, 2012)

1084-35-249 **Yu Wang*** (yuwang@math.columbia.edu), 2990 Broadway, Room 506 4406, New York, NY 10027. *Small Perturbation Solutions for Parabolic Equations.*

Let φ be a smooth solution of the parabolic equation $F(D^2u, Du, u, x, t) - u_t = 0$. Assume that F is smooth and uniformly elliptic only in a neighborhood of the points $(D^2\varphi, D\varphi, \varphi, x, t)$, we show that a viscosity solution u to the above equation is smooth in the interior if u is sufficiently close to φ in L^∞-norm. In the proof, we introduce the concept of parabolic balls which seems more convenient in performing covering arguments for parabolic equations. (Received September 05, 2012)

1084-35-261 **Robert Buckingham***, Department of Mathematical Sciences, University of Cincinnati, PO Box 210025, Cincinnati, OH 45221-0025, and **Peter D. Miller**. *Painlevé functions and critical behavior in the sine-Gordon equation.*

The solution to a Cauchy problem for a nonlinear wave equation often exhibits two or more qualitatively different behaviors in different regions of space-time (such as having an oscillatory zone and a non-oscillatory zone). The boundaries between these regions may become well-defined in certain limits, such as small dispersion or short time. It is then natural to consider the transition behavior between the two regions. In the past three years, it has been discovered that for several equations, including the Kortweg-de Vries, nonlinear Schrodinger, and Camassa-Holm equations, that certain critical behavior can be described for wide classes of initial conditions in

terms of Painlevé functions. These functions, which are solutions of nonlinear ordinary differential equations, seem to play a role for nonlinear equations analagous to the role played by the classical special functions for linear equations. We will discuss recent work with P. Miller using the Riemann-Hilbert approach on Painlevé-type asymptotics in solutions of the sine-Gordon equation, which in turn has led to a better understanding of interesting behavior of certain Painlevé II functions. (Received September 03, 2012)

1084-35-264 **Martina Chirilus-Bruckner*** (martina_chirilus-bruckner@brown.edu) and **Clarence Eugene Wayne**. *On the existence of breathers in periodic media: Inverse spectral theory for open gap potentials.*

The concept of breathers, i.e. time-periodic, spatially localized excitations, has been introduced in the context of the Sine-Gordon equation, which, however, seems to be the only (constant coefficient) nonlinear wave equation to support such solutions. In this sense, breathers have been considered a rare phenomenon. Surprisingly, a nonlinear wave equation with spatially periodic step potentials has been found recently to support breathers (Blank et al. 2010) by using a combination of spatial dynamics, center manifold reduction and bifurcation theory. Via inverse spectral theory, we aim towards characterizing a larger class of potentials that allow breathers. The research is motivated by the quest of using photonic crystals as optical storage. (Received September 03, 2012)

1084-35-288 **Leonardo Marazzi*** (leonardo.marazzi@uky.edu), 715 Patterson Office, Department of Mathematics, University of Kentucky, Lexington, KY 40506-0027. *Generic properties of surfaces with cusps.* Preliminary report.

We discuss how absence of embedded eigenvalues, infinitely many resonances and maximum order of growth of the counting function are generic properties for compact metric perturbations of finite area non-compact hyperbolic surfaces. This is joint work with P. Hislop and P. Perry. (Received September 03, 2012)

1084-35-300 **Steve Zelditch*** (zelditch@math.northwestern.edu), Northwestern, Evanston, IL 60208, and **Chris Sogge**. *Lp norms of eigenfunctions.*

I will go over some recent results on Lp norms of eigenfunctions for certain p and for certain Riemannian manifolds. In particular, I will consider L4 norms. (Received September 04, 2012)

1084-35-316 **Jack Xin** and **Yifeng Yu*** (yyu1@math.uci.edu). *Sharp asymptotic growth laws of turbulent flame speeds in cellular flows by inviscid Hamilton-Jacobi models.*

Turbulent combustion is an extremely complicated phenomenon. Progress in theoretical understanding and efficient modeling often relies on simplified models. In the talk, I will compare the popular G-equation model and a model introduced by Majda and Souganidis in 90's. The main result is about the sharp growth law of turbulent flame speeds predicted by these two models in the 2d cellular flow. This is a joint work with Jack Xin. (Received September 04, 2012)

1084-35-318 **Bo Guan*** (guan@math.osu.edu), Department of Mathemtics, Ohio State University, Columbus, OH 43210. *Second order estimates for fully nonlinear elliptic equations.*

We present some new methods to derive a priori estimates for second order derivatives of solutions to fully nonlinear elliptic equations, using subsolutions and the strict concavity of the equation. We'll consider both boundary and global estimates. The methods apply to very general equations and therefore give new and improve previously known results as well. In this talk we shall focus on elliptic equations on Riemannian manifolds. (Received September 04, 2012)

1084-35-319 **Bo Guan*** (guan@math.osu.edu), Department of Mathematics, Ohio State University, Columbus, OH 43210. *On the Dirichlet problem for fully nonlinear elliptic equations on complex manifolds.*

We are concerned with the Dirichlet problem for fully nonlinear elliptic equations on Kahler or Hermitian manifolds and seek general methods to overcome difficulties in deriving a priori estimates. The new methods, which are based on subsolutions and a strict concavity property, work for a very general class of equations. (Received September 04, 2012)

1084-35-324 **Dmitry Kurochkin*** (dkurochk@tulane.edu), 6823 St. Charles Ave, New Orleans, LA 70118, and **Alexander Kurganov** (kurganov@tulane.edu), 6823 St. Charles Ave, New Orleans, LA 70118. *Numerical Method for Constrained Optimization Problems Governed by Systems of Nonlinear Hyperbolic PDEs.*

We develop a numerical methods for optimization problems governed by systems of nonlinear hyperbolic PDEs. The optimization problem is equivalent to minimizing an objective functional subject to the system of conservation or balance laws. The iterative scheme is based on numerical solution of the system of conservation laws

forward in time and the corresponding system of adjoint equations backward in time. While high-resolution schemes for systems of nonlinear conservation and balance laws are readily available, solving the nonconservative adjoint system of linear PDEs with discontinuous coefficients is an extremely challenging task. In this work, we focus on developing of an accurate scheme for the backward equation in the context of the constrained optimization problem. The optimization method has been applied to the one-dimensional system of Euler Equations of gas dynamics. (Received September 04, 2012)

1084-35-330 **Magdalena Czubak*** (czubak@math.binghamton.edu) and **Robert L. Jerrard**. *Cosmic strings in the abelian Higgs model.*

We give a rigorous description of the dynamics of the Nielsen-Olesen vortex line. In particular, given a worldsheet of a string, we construct initial data such that the corresponding solution of the abelian Higgs model will concentrate near the evolution of the string. Moreover, the constructed solution stays close to the Nielsen-Olesen vortex solution. (Received September 04, 2012)

1084-35-336 **Charles K Smart*** (smart@math.mit.edu), Department of Mathematics, MIT, 2-339, 77 Massachusetts Avenue, Cambridge, MA 02139. *Regularity and stochastic homogenization of fully nonlinear equations without uniform ellipticity.*

Joint with Scott N. Armstrong: We prove regularity and stochastic homogenization results for certain degenerate elliptic equations in nondivergence form. The equation is required to be strictly elliptic, but the ellipticity may oscillate on the microscopic scale and is only assumed to have a finite dth moment, where d is the dimension. In the general stationary-ergodic framework, we show that the equation homogenizes to a deterministic, uniformly elliptic equation, and we obtain an explicit estimate of the effective ellipticity which is new even in the uniformly elliptic context. Showing that such an equation behaves like a uniformly elliptic equation requires a novel reworking of the regularity theory. We show that the moment condition is sharp by giving an explicit example of an equation whose ellipticity has a finite pth moment, for every $p < d$, but for which regularity and homogenization break down. While these results are new even for linear equations, we prove them in the fully nonlinear context. In probabilistic terms, our homogenization results correspond to quenched invariance principles for controlled diffusion processes in random media, including linear diffusions as well as diffusions controlled by one controller or two competing players. (Received September 04, 2012)

1084-35-337 **Nicola Garofalo*** (rembrandt54@gmail.com), **Donatella Danielli**, **Arshak Petrosyan** and **Tung To**. *Recent progress in the parabolic Signorini problem.* Preliminary report.

I will present some recent results in the parabolic lower-dimensional obstacle problem. I will discuss the optimal interior regularity of the solution and the smoothness of the free boundary. Various new monotonicity formula will be discussed. (Received September 04, 2012)

1084-35-367 **Alin Pogan*** (apogan@indiana.edu), Department of Mathematics, Indiana University, Rawles Hall, 831 East 3rd St, Bloomington, IN 47405, **Arnd Scheel**, University of Minnesota, School of Mathematics, 206 Church Street S.E, Minneapolis, MN , and **Kevin Zumbrun**, Department of Mathematics, Indiana University, Rawles Hall, 831 East 3rd St, Bloomington, IN. *Quasi-Gradient Systems, Modulational Dichotomies, and Stability of spatially periodic patterns.*

We discuss relations between the constrained variational problem and stability of solutions of a class of degenerate "quasi-gradient" systems admitting constraints, including Cahn-Hilliard equations, one- and multi-dimensional viscoelasticity, and coupled conservation law-reaction diffusion systems arising in chemotaxis and related settings. Using the relation between variational stability and the signature of $\frac{\partial c}{\partial \omega}$, where c denote the values of the imposed constraints and ω the associated Lagrange multipliers at a given critical point, we obtain as in the Hamiltonian case a general criterion for co-periodic stability of periodic waves, illuminating and extending a number of previous results obtained by direct Evans function techniques. We also prove that co-periodic and sideband stability are incompatible for all of these models. (Received September 04, 2012)

37 ► Dynamical systems and ergodic theory

1084-37-17 **Kelly Brooke Yancey*** (funk3@illinois.edu). *Homeomorphisms of the Klein Bottle.*

In this talk I will show how to obtain the Klein bottle from the two torus quotiented by an appropriate group action. We will then discuss how to produce a large family of topologically weakly mixing homeomorphisms of the Klein bottle that are uniformly rigid. (Received July 09, 2012)

1084-37-159 **Kelly McQuighan***, kelly_mcquighan@brown.edu, and **Bjorn Sandstede**. *Oscillons near Planar Forced Hopf Bifurcations.* Preliminary report.

Oscillons are planar, spatially localized, temporally oscillating, radially symmetric structures. They have been observed in various experimental contexts, including fluid systems, granular systems, and chemical systems. Oscillons often arise near forced Hopf bifurcations, which are modeled mathematically with the forced complex Ginzburg-Landau (FCGL) equation. We present a proof of the existence of oscillons in the forced planar complex Ginzburg-Landau equation through a geometric blow-up analysis. Our analysis is complemented by a numerical continuation study of oscillons in the forced Ginzburg-Landau equation using Matlab and AUTO. (Received August 30, 2012)

42 ► Fourier analysis

1084-42-40 **Alex Iosevich*** (iosevich@math.rochester.edu), 145 Dunrovin Lane, Rochester, NY 14618. *Trace inequalities, multi-linear operators and applications to geometric measure theory.*

We shall prove a class of convolution trace inequalities and use them to obtain previously unknown results in maximal operator theory and geometric measure theory. (Received August 11, 2012)

1084-42-123 **Oleksandr (Alexander) V Tovstolis*** (atovstolis@math.okstate.edu), Department of Mathematics, Oklahoma State University, 401 Mathematical Sciences, Stillwater, OK 74078. *Fourier multipliers in Hardy spaces in tubes over open cones and inequalities for entire functions of exponential type.*

Let $\mathcal{M}_{p,q}(T_\Gamma)$ be the class of Fourier multipliers from $H^p(T_\Gamma)$ to $H^q(T_\Gamma)$, $0 < p \le q \le 1$, in tubes over a regular cone $\Gamma \subset \mathbb{R}^n$. Several conditions for multipliers are obtained. Results like

Theorem 1. *Let $\varphi : \mathbb{R}^n \to \mathbb{C}$ be a continuous compactly supported radial function. If in some neighborhood of the origin, φ coincides with a continuous compactly supported function whose Fourier transform belongs to $L^q(\mathbb{R}^n)$, for some $q \in (0,1]$, then, with any $p \in (0,q]$, $\varphi \in \mathcal{M}_{p,q}(T_\Gamma)$ if and only if $\widehat{\varphi} \in L^q(\mathbb{R}^n)$.*

are applied to discovering the critical index for Bochner-Riesz means.
Inequalities for entire functions of exponential type belonging to H^p are obtained.

Theorem 2 (Bernstein-type inequality)**.** *Let $p \in (0,\infty)$, and K be a symmetric body in $\mathbb{R}^n$. Then, for $f \in \mathcal{E}(K^*) \cap H^p(T_\Gamma)$ and a multi-index $k = (k_1, \dots, k_n)$,*

$$\left\| \frac{\partial^{|k|} f}{\partial z_1^{k_1} \dots \partial z_n^{k_n}} \right\|_{H^p} \le (2\pi)^{|k|} \prod_{j=1}^{n} \sigma_j^{k_j} \|f\|_{H^p},$$

where $\sigma_j := \max_{t \in K \cap \Gamma^*} |t_j|$.

(Received August 27, 2012)

1084-42-209 **Leonid Slavin*** (leonid.slavin@uc.edu), Department of Mathematical Sciences, University of Cincinnati, Cincinnati, OH 45221. *Inverse Bellman functions and the exponential integrability of BMO.*

The sharp constants in the John–Nirenberg inequality for BMO,

$$\frac{1}{|Q|} |\{t \in Q : |\varphi(t) - \langle\varphi\rangle_Q| \ge \lambda\}| \le C_1 e^{-c_0 \lambda / \|\varphi\|_{\mathrm{BMO}}},$$

depend on the choice of the norm; of principal interest is the constant c_0. For the L^p-based BMO, $c_0 = c_0(p)$ has proved difficult to compute. Until recently, the only results in this direction were by Korenovskii ($c_0(1) = 2/e$) and Vasyunin ($c_0(2) = 1$). The latter result uses Bellman functions; however, even though these functions can be formally defined for any $p > 0$, they cannot be directly computed, unless $p = 2$. This difficulty was recently overcome (so far, for $1 \le p \le 2$) by considering the dual problem of estimating (from below) the BMO^p norms of logarithms of A_∞ weights. It turns out that the corresponding Bellman functions are inverses, in an appropriate sense, of those for the original problem. The main result is

$$c_0(p) = \left[\frac{p}{e} \Big(\Gamma(p) - \int_0^1 t^{p-1} e^t \, dt \Big) + 1 \right]^{1/p}, \quad 1 \le p \le 2.$$

The proof relies on finding optimal convex solutions of the homogeneous Monge–Ampère equation on a non-convex plane domain. (Received September 02, 2012)

1084-42-225 **Konstantin A Makarov*** (makarovk@missouri.edu), Department of Mathematics, University of Missouri, Columbia, MO 65211. *A remark on convolutions.* Preliminary report.

Let μ be a probability measure on a finite interval with a smooth density ρ. We study the asymptotic behavior of the infinite series

$$F(x) = \sum_{n=1}^{\infty} \frac{1}{n} \underbrace{\rho \star \rho \star \cdots \star \rho}_{n \text{ times}}(x)$$

as $x \to \infty$, where $f \star g$ stands for the convolution of f and g. (Received September 02, 2012)

1084-42-229 **Andreas Seeger***, Department of Mathematics, University of Wisconsin-Madison, Madison, WI 53706. *A weak type bound for a singular integral.*

A weak type $(1,1)$ estimate is established for the first order d-commutator introduced by Christ and Journé, in dimension $d \geq 2$. (Received September 02, 2012)

1084-42-254 **David V. Cruz-Uribe*** (david.cruzuribe@trincoll.edu), Department of Mathematics, Trinity College, 300 Summit St., Hartford, CT 06110. *The rise, fall and rebirth of the Muckenhoupt-Wheeden conjecture.*

Muckenhoupt and Wheeden conjectured that given weights u, v and $1 < p < \infty$, the Hilbert transform satisfies $H : L^p(v) \to L^p(u)$ if the maximal operator satisfies $M : L^p(v) \to L^p(u)$ and the "dual" inequality $M : L^{p'}(u^{1-p'}) \to L^{p'}(v^{1-p'})$. They also conjectured that the dual inequality was sufficient for the weak (p,p) inequality $H : L^p(v) \to L^{p,\infty}(u)$. While very attractive, these conjectures are false: this was proved for the strong-type inequality by Reguera and Scurry, and for the weak-type by us with Reznikov and Volberg. On the other hand, we proved with Martell and Pérez that this conjecture is true for L^p, L^q inequalities when $p < q$. And, working with Moen, we proved that a related conjecture for Riesz potentials is also true when $p < q$. We will discuss these results and explore their connection with the A_p bump conditions. These were introduced by Pérez in the 1990s, motivated by the Muckenhoupt-Wheeden conjecture. We give a new condition that was implicit in his work, and describe a partial result in the scale of log-bumps, joint with Volberg and Reznikov. We will also discuss a related theorem for Riesz potentials from work with Moen. (Received September 03, 2012)

1084-42-273 **Dmitriy Bilyk*** (dbilyk@math.umn.edu), School of Mathematics, University of Minnesota, 206 Church St. SE, Minneapolis, MN 55455. *Discrepancies with respect to various set systems.*

Discrepancy is a natural way to measure the extent of uniformity of a finite distribution by comparing the generated empirical measure to the Lebesgue measure over a certain family of sets. It is well-known that the arising estimates heavily depend on the geometry of the underlying sets. For example, fixed-direction rectangles on one hand, and arbitrarily rotated rectangles or discs on the other yield completely different asymptotics. We try to deeper understand these phenomena, obtain intermediate estimates, and relate these questions to other problems. The methods of Fourier analysis and number theory turn out to be crucial. Part of this talk is based on joint work with X. Ma, J. Pipher, C. Spencer. (Received September 03, 2012)

1084-42-301 **Betsy Stovall*** (stovall@math.wisc.edu). *Uniform L^p improving for weighted averages on curves.*

We discuss generalizations of affine arclength measure and $L^p \to L^q$ estimates for certain averaging operators. (Received September 04, 2012)

1084-42-308 **Geoff Diestel***, 1001 Leadership Place, Killeen, TX 76549, and **Loukas Grafakos**. *Trivial Translation Invariant Multilinear Operators.* Preliminary report.

Let $1 \leq p_1, \cdots, p_k < \infty$ and $1/q > 1/p_1 + \cdots + 1/p_k$. Then $T : L_{p_1}(\mathbf{R}^n) \times \cdots \times L_{p_k}(\mathbf{R}^n) \to L_q(\mathbf{R}^n)$ is a continuous k-linear translation invariant operator if and only if $T = 0$. For $q \geq 1$, the result follows from combining the known proof in the linear case with a subtle symmetry argument. To extend the result to $q < 1$ we use a weak-compactness argument from general factorization theory. Additional connections between translation invariant multilinear operators and recent advances in mulitilinear factorization theory are presented. (Received September 04, 2012)

1084-42-331 **Michael T. Lacey** (lacey@math.gatech.edu), School of Mathematics, Georgia Institute of Technology, Atlanta, GA 30332, **Eric T. Sawyer** (sawyer@mcmaster.ca), Dept. of Mathematics & Statistics, McMaster University, 1280 Main Street West, Hamilton, Ontario L8S 4K1, Canada, **Chun-Yen Shen** (cyshen@math.msu.edu), Department of Mathematics, Michigan State University, 619 Red Cedar Road, East Lansing, MI 48824, and **Uriarte-Tuero Ignacio*** (ignacio@math.msu.edu), Department of Mathematics, Michigan State University, 619 Red Cedar Road, East Lansing, MI 48824. *Two Weight Inequality for the Hilbert Transform: A Real Variable Characterization.*

The two weight inequality for the Hilbert transform arises in the settings of analytic function spaces, operator theory, and spectral theory, and what would be most useful is a characterization in the simplest real-variable terms. In joint work with Lacey, Sawyer and Shen, we show that the L^2 to L^2 inequality holds if and only if two L^2 to weak-L^2 inequalities hold. This is a corollary to a characterization in terms of a two-weight Poisson inequality, and a pair of testing inequalities on bounded functions. (Received September 04, 2012)

45 ► Integral equations

1084-45-72 **Michael Bolt** and **Andrew Raich*** (araich@uark.edu), Department of Mathematical Sciences, 1 University of Arkansas, SCEN 327, Fayetteville, AR 72701. *The Kerzman-Stein operator for piecewise continuously differentiable regions.*

The Kerzman-Stein operator is the skew-hermitian part of the Cauchy operator defined with respect to an unweighted hermitian inner product on a rectifiable curve. If the curve is continuously differentiable, the Kerzman-Stein operator is compact on the Hilbert space of square integrable functions; when there is a corner, the operator is noncompact. Here we give a complete description of the spectrum for a finite symmetric wedge and we show how this reveals the essential spectrum for curves that are piecewise continuously differentiable. We also give an explicit construction for a smooth curve whose Kerzman-Stein operator has large norm, and we demonstrate the variation in norm with respect to a continuously differentiable perturbation. (Received August 21, 2012)

46 ► Functional analysis

1084-46-87 **Warren B. Moors*** (moors@math.auckland.ac.nz), Warren B. Moors, Department of Mathematics, The University of Auckland, Private Bag 92019, Auckland, 1142, New Zealand. *Pseudo-compact semi-topological groups.*

A semitopological group (topological group) is a group endowed with a topology for which multiplication is separately continuous (multiplication is jointly continuous and inversion is continuous). In this paper we give some topological conditions on a semitopological group that imply that it is a topological group. For example, we show that every separable pseudocompact semitopological group is a topological group. We also show that every locally pseudocompact semitopological group whose multiplication is jointly continuous is a topological group. (Received August 23, 2012)

1084-46-110 **Richard Rochberg*** (rr@math.wustl.edu), 6936 Cornell Ave., University City, MO 63130. *The Maximal Ideal Space of the Multiplier Algebra of the Dirichlet Space.* Preliminary report.

Let H^2 and $\mathcal{D}$ be the classical Hardy space and Dirichlet space, $H^\infty = \mathcal{M}(H^2)$ and $\mathcal{M}(\mathcal{D})$ their respective multiplier algebras, and $\mathcal{MI}(H^\infty)$ and $\mathcal{MI}(\mathcal{M}(\mathcal{D}))$ the maximal ideal spaces of those algebras. H^∞ and $\mathcal{MI}(H^\infty)$ have been studied extensively, both because of their intrinsic interest and because of their intimate relationship to the operator theory of H^2.

Also, we now know that there are deep analogies which relate H^2 and $\mathcal{D}$. Perhaps $\mathcal{M}(\mathcal{D})$ and $\mathcal{MI}(\mathcal{M}(\mathcal{D}))$ have rich structure that is, in some ways, similar to that of H^∞ and $\mathcal{MI}(H^\infty)$.

In this talk I will discuss some preliminary observations and questions related to this speculation. (Received August 28, 2012)

1084-46-137 **Bernardo Cascales*** (beca@um.es), Departamento de Matematicas, Campus de Espinardo, Universidad de Murcia, 30100 Murcia, Spain. *Fragmentatility, things that I learned from I. Namioka.*

In this lecture we will present a collection of results with the common link of fragmentability underneath. Namely, we will present results about the relationship between fragmentatility and the Lindelöf property in Banach spaces (from joint papers with I. Namioka and J. Orihuela), results about fragmentability and distances to spaces of

Baire one functions (from a joint paper with C. Angosto and I. Namioka) and results about fragmentability and the Bishop-Phelps-Bollobás property (from joint papers with R. M. Aron, A. J. Guirao, V. Kadets and O. Kozhushkina).

The papers related to this lecture can be downloaded from:
http://webs.um.es/beca/papers.html (Received August 29, 2012)

1084-46-274 **N. Lovasoa Randrianarivony*** (nrandria@slu.edu), Saint Louis University, and **Stephen Dilworth**, **Denka Kutzarova** and **Gilles Lancien**. *The transfer of property (β) of Rolewicz by a nonlinear map.*

In 1987, Rolewicz introduced a geometric property (β) of Banach spaces as an asymptotic generalization of uniform convexity. The talk will present the latest progress in the understanding of the role that this geometric property plays in the study of nonlinear maps between Banach spaces, especially uniform quotient maps. As time permits, we will go into the quantitative measurement of this property compared to other asymptotic moduli. (Received September 03, 2012)

1084-46-304 **Todd Kapitula*** (tmk5@calvin.edu), Department of Mathematics and Statistics, Calvin College, Grand Rapids, MI 49546. *Instability index theorems for polynomial pencils.*

In many physical problems the descriptive mathematical model is of such a form that the stability of an underlying wave is determined by finding the spectrum of a polynomial pencil, i.e., a polynomial in the spectral parameter whose coefficients are operators. In this talk I will describe recent work in which the number of unstable eigenvalues, i.e., those zeros of the polynomial with positive real part, can be determined through a spectral analysis of the coefficient operators. (Received September 04, 2012)

1084-46-351 **Alexander A. Katz*** (katza@stjohns.edu), St. John's University, St. John's College, Dep. of Math & CS, 300 Howard Ave., DaSilva AC 314, Staten Island, NY 10301. *On the universal enveloping B-C*-algebra for a B-JB-algebra.*

In the paper we give a Boolean-valued interpretation of the theorem of Alfsen, Hanche-Olsen and Shultz on the existence and uniqueness of the universal enveloping C*-algebra for a JB-algebra. (Received September 04, 2012)

47 ► Operator theory

1084-47-27 **Ronald G. Douglas*** (rdouglas@math.tamu.edu), TAMU 3368, College Station, TX 77843, and **Yun Su Kim**, **Hyun Kyoung Kwon** and **Jaydeb Sarkar**. *Canonical models and similarity.*

An effective approach to the study of contraction operators on Hilbert space is the canonical model theory of Sz.-Nagy and Foias. Here we generalize the notion of canonical model to the context of reproducing kernel Hilbert spaces of holomorphic functions. The generalization uses the language of Hilbert modules and includes the multivariate case as well as the one variable case. We consider when such models are unitarily equivalent and, in some cases, similar. The methods and techniques used rely heavily on complex geometry. (Received July 31, 2012)

1084-47-78 **Zeljko Cuckovic*** (zcuckovi@math.utoledo.edu), University of Toledo, Department of Mathematics, 2801 W. Bancroft St., Toledo, OH 43606, and **Trieu Le**, University of Toledo, Department of Mathematics, 2801 W. Bancroft St., Toledo, OH 43606. *Berezin transform on Bergman spaces of polyanalytic functions.*

We are interested in algebraic properties of Toeplitz operators on Bergman spaces of polyanalytic functions on the unit disk. For that reason we study certain properties of the Berezin transform on these spaces. (Received August 22, 2012)

1084-47-96 **Wolfram Bauer** and **Trieu Le*** (trieu.le2@utoledo.edu). *Finite rank Toeplitz operators on the Segal–Bargmann space.*

The Segal–Bargmann space $\mathcal{H}^2(\mathbb{C})$ consists of entire functions that are square integrable with respect to the Gaussian measure on $\mathbb{C}$. For any bounded measurable function φ, the Toeplitz operator T_φ is the compression of the multiplication operator M_φ on $\mathcal{H}^2(\mathbb{C})$. It follows from Daniel Luecking's result in 2007 that if T_φ has finite rank and φ is supported on a bounded set, then φ must vanish almost everywhere. In this talk, we will discuss the case when φ has an unbounded support. (Received August 25, 2012)

1084-47-153 **Raúl E. Curto*** (raul-curto@uiowa.edu), Department of Mathematics, The University of Iowa, Iowa City, IA 52242. *Subnormality of block Toeplitz operators on the Hardy space of the unit circle.*

In joint work with I.S. Hwang and W.Y. Lee, we study subnormal Toeplitz operators on the vector-valued Hardy space of the unit circle, along with an appropriate reformulation of P.R. Halmos's Problem 5: Which subnormal block Toeplitz operators are either normal or analytic? We extend and prove Abrahamse's Theorem to the case of matrix-valued symbols; that is, we show that every subnormal block Toeplitz operator with bounded type symbol (i.e., a quotient of two bounded analytic functions), whose analytic and co-analytic parts have the "left coprime factorization," is normal or analytic. We also prove that the left coprime factorization condition is essential.

We then apply this and related results to solve the following "Toeplitz completion" problem: Find the unspecified Toeplitz entries of the partial block Toeplitz matrix

$$A := \begin{bmatrix} T_z^* & ? \\ ? & T_z^* \end{bmatrix}$$

so that A becomes subnormal, where T_z is the unilateral shift on H^2. (Received August 29, 2012)

51 ► Geometry

1084-51-20 **J. Ding***, Department of Mathematics, University of Southrn Mississippi, Hattiesburg, MS 39406. *Dynamical geometry for secondary teachers.*

Discrete dynamical geometry studies eventual behavior of iterated geometric figures such as triangles and polygons. We have developed a course on dynamical geometry at the University of Southern Mississippi for the training of secondary mathematics teachers as well as mathematics majors who have studied elementary linear algebra. This course combines basic theory of stochastic matrices, modern ideas of chaos and fractals, and web-based demonstration. We present the philosophy behind the course and outline its contents. (Received July 18, 2012)

1084-51-112 **Mark W Meckes*** (mark.meckes@case.edu), Case Western Reserve University, Dept. of Mathematics, 10900 Euclid Ave., Cleveland, OH 44106. *The magnitude of metric spaces.*

Magnitude is a partially defined numerical invariant of metric spaces introduced recently by Tom Leinster, motivated by considerations from category theory, which generalizes the cardinality of a finite set. I will discuss some of what is known and not known about magnitude, highlighting connections with harmonic analysis, intrinsic volumes (in both convex and Riemannian geometry), and biodiversity. This is work of Tom Leinster, Simon Willerton, and myself. (Received August 27, 2012)

1084-51-220 **Rieuwert J. Blok*** (rblok@bgsu.edu). *Highest weight modules and polarized embeddings of shadow spaces.*

Let Δ be the spherical building with diagram M over an index set $I = \{1, 2, \ldots, n\}$ associated to a group G of Lie type via its BN-pair. Fix a proper subset $K \subset I$. The Weyl module V for G of highest weight $\sum_{k \in K} \lambda_k$ affords an embedding for the K-shadow space of Δ. We discuss some algebraic and geometric properties of this embedding. (Received September 02, 2012)

1084-51-230 **Tam Nguyen-Phan*** (nguyenphan.1@osu.edu), 231 W. 18th St, Columbus, OH 43210. *Ends of finite volume, negatively curved manifolds.* Preliminary report.

Let M be a complete, Riemannian manifold with finite volume. Gromov proved that if the sectional curvature of M is $-1 < K(M) < 0$, then M is diffeomorphic to the interior of a compact manifold $\overline{M}$ with boundary $\partial\overline{M}$. I will discuss the topology of $\partial\overline{M}$. I will also talk about which $\partial\overline{M}$ can occur when M has low dimension (less than 5). (Received September 02, 2012)

To add "Preliminary report" after the title, uncomment this line:

1084-51-256 **Dennis Glenn Collins*** (d_collins_pr@hotmail.com), 1519 S. State Rd. 119, Apt. 2, Winamac, IN 46996-8550. *Approximating Continuous Symmetry of Some Surfaces and Solids.* Preliminary report.

This work approximates the continuous symmetry of some surfaces and solids according to the definition of the author's patent (continuous symmetry=negentropy=negative positional entropy), mostly by Monte Carlo methods, but with some theoretical comparisons. These calculations extend previous one-dimensional work.

Some results from Mathematica programs, recalling the Monte Carlo values come out different for each run of the program:

Geometric Figure Theoretical Monte Carlo two-dim strip 16x(1/16) -2.52 two-dim rectangle 4x(1/4) -1.17 two-dim square 1x1 .0095697 .00859 two-dim circular disk .0502557 .044 r=1/Sqrt[Pi] two-dim tent .117 adjacent squares side= 1/Sqrt[2] at 90 degree angle hemisphere surface r=1/Sqrt[2Pi] .36 cube surface side=1/Sqrt[6] .75 sphere surface r= 1/Sqrt[4Pi] .743403 .77 solid square rod 16x(1/4)x(1/4) -2.57 rectangular slab 4x4x(1/16) -1.36 solid cube 1x1x1 .031 solid sphere r=$(3/(4\mathrm{Pi}))^{(1/3)}$ .0550511. (Received September 03, 2012)

1084-51-275 **Grigori I Avramidi*** (gavramid@math.uchicago.edu). *Action dimension of right angled Artin groups.* Preliminary report.

A right angled Artin group is a group with a presentation determined by a finite graph in the following way: the generators are the vertices of the graph and two generators commute if the corresponding vertices are connected by an edge. These interpolate between free groups and free abelian groups and arise as fundamental groups of some nonpositively curved complexes, which are usually not manifolds. I will discuss ways to determine the minimal dimension of an aspherical manifold whose fundamental group is a given right angled Artin group. This is part of a joint project with Mike Davis and Boris Okun. (Received September 03, 2012)

1084-51-335 **Wouter Van Limbeek*** (limbeek@math.uchicago.edu), Dept of Mathematics, University of Chicago, 5734 S University Ave, Chicago, IL 60637. *Riemannian manifolds with nontrivial local symmetry.* Preliminary report.

In this talk I will discuss the problem of classifying all closed Riemannian manifolds whose universal cover has nondiscrete isometry group. Farb and Weinberger solved this under the additional assumption that M is aspherical: roughly, they proved M is a fiber bundle with locally homogeneous fibers. However, if M is not aspherical, many new examples and phenomena appear. I will exhibit some of these, and discuss progress towards a classification. One new ingredient is Frankel's technique of averaging a harmonic map, which may be of independent interest. (Received September 04, 2012)

1084-51-345 **Patrick Michael Boland***, pboland@umich.edu. *Scattering geodesics: Sojourn times and self intersections.* Preliminary report.

On noncompact hyperbolic surfaces, two interesting types of curves are closed and scattering geodesics. The length of a closed geodesic and "sojourn time" of a scattering geodesic are important geometric quantities. Inspired by Ara Basmajian's paper "Universal length bounds for non-simple closed geodesics on hyperbolic surfaces", we investigate a relationship between the sojourn time of a scattering geodesic and its number of self intersections. (Received September 04, 2012)

1084-51-361 **Brandon M. Seward*** (bseward@umich.edu), Department of Mathematics, 2074 East Hall, 530 Church Street, Ann Arbor, MI 48109. *The Geometric Burnside's Problem.*

Burnside's Problem and the von Neumann Conjecture are classical problems from group theory which were long ago answered in the negative. In 1999, Kevin Whyte defined geometric analogs of these problems and proved the Geometric von Neumann Conjecture. In this talk, I will present a proof of the Geometric Burnside's Problem. I will also present a strengthening of Whyte's result and draw conclusions about the existence of regular spanning trees of Cayley graphs. (Received September 04, 2012)

1084-51-370 **James Vargo*** (vargo@math.tamu.edu). *Reconstructing the path of a photon from* 1 *dimensional projected length measurements.*

Consider a piecewise differentiable curve of finite length in n dimensional space. For each line l, we orthogonally project the curve onto the line and integrate the absolute value of the resultant velocity function to obtain a measurement $M(l)$. In this talk, we will discuss the properties of the original curve that can be determined from such measurements. And we will discuss the tomography problem that gave rise to this geometry problem. (Received September 05, 2012)

52 ► Convex and discrete geometry

1084-52-28 **Matthias Beck**, **Pallavi Jayawant** and **Tyrrell B. McAllister*** (tmcallis@uwyo.edu). *Lattice-point generating functions for free sums of convex sets.*

Let $\mathcal{J}$ and $\mathcal{K}$ be convex sets in $\mathbb{R}^n$ whose affine spans intersect at a single rational point in $\mathcal{J} \cap \mathcal{K}$, and let $\mathcal{J} \oplus \mathcal{K} = \mathrm{conv}(\mathcal{J} \cup \mathcal{K})$. We give expressions for the generating function

$$\sigma_{\mathcal{J}\oplus\mathcal{K}}(z_1, \ldots, z_n) = \sum_{(m_1,\ldots,m_n)\in(\mathcal{J}\oplus\mathcal{K})\cap\mathbb{Z}^n} z_1^{m_1} \cdots z_n^{m_n}$$

in terms of $\sigma_{\mathcal{J}}$ and $\sigma_{\mathcal{K}}$, under certain conditions on $\mathcal{J}$ and $\mathcal{K}$. This work is motivated by (and recovers) a product formula of B. Braun for the Ehrhart series of $\mathcal{P} \oplus \mathcal{Q}$ in the case where $\mathcal{P}$ and $\mathcal{Q}$ are lattice polytopes, one of which is reflexive. (Received August 01, 2012)

1084-52-37 **Alexander Koldobsky*** (koldobskiya@missouri.edu), Department of Mathematics, University of Missouri, Columbia, MO 65211. *Stability and separation in volume comparison problems.*

We establish stability and separation in several volume comparison problems, including the Busemann-Petty and Shephard problems on sections and projections of convex bodies. Then we show how these properties can be used to prove hyperplane inequalities for certain classes of bodies. (Received August 11, 2012)

1084-52-41 **Elisabeth M Werner*** (elisabeth.werner@case.edu), Department of Mathematics, Case Western Reserve University, Cleveland, OH 44106, and **Shiri Artstein-Avidan**, **Boaz Klartag** and **Carsten Schuett**. *Functional affine-isoperimetry and an inverse logarithmic Sobolev inequality.*

We give a functional version of the affine isoperimetric inequality for log-concave functions which may be interpreted as an inverse form of a logarithmic Sobolev inequality inequality for entropy. A linearization of this inequality gives an inverse inequality to the Poincare inequality for the Gaussian measure. (Received August 11, 2012)

1084-52-136 **Kevin Woods*** (kevin.woods@oberlin.edu). *The Unreasonable Ubiquitousness of Quasi-polynomials.* Preliminary report.

Ehrhart functions and vector partition functions are well-studied objects known to have quasi-polynomial behavior. These are functions counting the number of lattice points in parametric polyhedra: facets are moving in and out, as determined by the input parameters, but the normal vectors to the facets remain constant. These are well-understood. Recently, several one-parameter functions have been shown to be (eventually) quasi-polynomial, even though the normal vectors of the parametric polyhedra are not remaining constant. We will survey recent results in that vein, including joint work with Bjarke Roune. (Received August 29, 2012)

1084-52-156 **Dmitry Ryabogin** and **Vladyslav Yaskin*** (yaskin@ualberta.ca), Department of Math & Stat Sciences, Univesity of Alberta, Edmonton, Alberta T6G 2G1, Canada. *Detecting symmetry in star bodies.*

We use Fourier transform techniques to prove a result on detecting symmetry in convex and star bodies with the help of conical sections. Our methods also allow us to give a new proof of the well-known theorem of Makai, Martini and Ódor about maximal hyperplane sections passing through the same point. (Received August 30, 2012)

1084-52-169 **Paul Goodey** and **Wolfgang Weil*** (wolfgang.weil@kit.edu). *Sums of Sections and the General Minkowski Problem.* Preliminary report.

For $2 \leq k \leq d-1$, the k-th mean section body, $M_k(K)$, of a convex body K in $\mathbb{R}^d$, is the Minkowski sum of all its sections by k-dimensional flats. We show that the characterization of these mean section bodies is equivalent to the solution of the general Minkowski problem, namely that of giving the characteristic properties of those measures on the unit sphere which arise as surface area measures (of arbitrary degree) of convex bodies. This equivalence arises from an integral representation of the support function of $M_k(K)$ in terms of the $(d+1-k)$-th surface area measure of K. The latter is obtained by Fourier transform techniques and involves the functions introduced by Berg (1969) in his solution of the Christoffel problem. (Received August 31, 2012)

1084-52-198 **Susanna Dann*** (danns@missouri.edu). *The Busemann-Petty Problem in Complex Hyperbolic Space.*

The Busemann-Petty problem asks whether origin-symmetric convex bodies in $\mathbb{R}^n$ with smaller central hyperplane sections necessarily have smaller volume. The answer is affirmative if $n \leq 4$ and negative if $n \geq 5$. We

study this problem in the complex hyperbolic space and prove that the answer is affirmative if $n \leq 2$ and negative if $n \geq 3$. (Received September 01, 2012)

1084-52-202 **Alexander E Litvak*** (aelitvak@gmail.com), Dept. of Math. and Stat. Sciences, Univ. of Alberta, Edmonton, AB T6G 1Z3, Canada, and **Mark Rudelson** and **Nicole Tomczak-Jaegermann**. *On projections of sections of a simplex.* Preliminary report.

We provide an affirmative answer to a problem posed by Barvinok and Veomett, showing that in general an n-dimensional convex body cannot be approximated by a projection of a section of a simplex of sub-exponential dimension. More precisely, we prove that for all $1 \leq n \leq N$ there exists an n-dimensional convex body B such that for every n-dimensional convex body K obtained as a projection of a section of an N-dimensional simplex one has

$$d(B, K) \geq c\sqrt{\frac{n}{\ln \frac{2N \ln(2N)}{n}}},$$

where $d(\cdot, \cdot)$ denotes the Banach-Mazur distance and c is an absolute positive constant. The result is sharp up to a logarithmic factor. (Received September 01, 2012)

1084-52-205 **M. Alfonseca-Cubero*** (maria.alfonseca@ndsu.edu), **F. Nazarov**, **D Ryabogin** and **A Zvavitch**. *t-sections of convex bodies.* Preliminary report.

We study the following problem: Let K be a convex body and let t be a small positive number. The t-sections of K are the intersections of K with hyperplanes tangent to the ball centered at the origin and with radius t. If all the t-sections of K have the same volume, is K a ball? We present a partial answer to this question in dimension 4. (Received September 01, 2012)

1084-52-211 **Alina Stancu*** (alina.stancu@concordia.ca), Department of Mathematics and Statistics, Montreal, QC H3G 1C9. *An application of curvature flows to convexity.*

We will present a class of $SL(n)$ invariant curvature flows on smooth strictly convex hypersurfaces in $\mathbb{R}^n$ whose long term existence and asymptotic behavior have implications in the theory of convex bodies. We will report also on some adjacent results obtained by M. Najafi Ivaki. (Received September 02, 2012)

1084-52-231 **Galyna V Livshyts*** (glivshyt@kent.edu), The Department of Mathematical Sciences, Kent State University, Kent, OH 44242. *Maximal surface area of a convex set in $\mathbb{R}^n$ with respect to exponential rotation invariant measures.*

Let p be a positive number. Consider probability measure γ_p with density $\varphi_p(y) = c_{n,p}e^{-\frac{|y|^p}{p}}$. We show that the maximal surface area of a convex body in $\mathbb{R}^n$ with respect to γ_p is asymptotically equal to $C_p n^{\frac{3}{4}-\frac{1}{p}}$, where constant C_p depends on p only. This is a generalization of Ball's and Nazarov's bounds, which were given for the case of the standard Gaussian measure γ_2. (Received September 04, 2012)

1084-52-235 **Manuel Weberndorfer*** (manuel.weberndorfer@tuwien.ac.at), Vienna University of Technology, Institute of Discrete Mathematics & Geometry, Wiedner Hauptstraße 8–10, 1040 Vienna, Austria. *On the volume of polars of convex bodies.*

New sharp volume inequalities for polars of asymmetric Wulff shapes and asymmetric L_p zonotopes are presented. These reverse affine isoperimetric inequalities generalize important known lower bounds for the volume of polars of convex bodies. In particular, they have as special cases Barthe's dual volume ratio inequality and Reisner's volume product inequality for zonoids. (Received September 03, 2012)

1084-52-244 **Eric L Grinberg*** (eric.grinberg@umb.edu), Department of Mathematics, UMass Boston, Boston, MA 02446. *Wave Front Sets in Convex Geometry.* Preliminary report.

We discuss the role and use of wave front sets, especially analytic ones, in the analysis of convex and star bodies. These tools from micro local analysis are of interest in unique-determination, rather than comparison, problems. Though we do not assume analyticity for the bodies in question, the uniqueness considerations lead to analytic differences and thus analytic continuation can be invoked. The goal is to determine a convex or star body from a 'thin' set of tomographic data. Typically it is assumed that some small initial data set is known a-priori and then uniqueness follows by analytic continuation using wavefront sets. The assumption of some small initial data does reduce generality, but is in the same spirit as the paradigms of other inverse problems, e.g., in cryptography. (Received September 03, 2012)

1084-52-251 **Jaegil Kim*** (jkim@math.kent.edu), Kent, OH 44242. *On the local minimality of the volume product.*

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 a fixed dimension. It is also asking whether or not the simplex is a minimizer for the volume product in the non-symmetric setting. In this talk we discuss the local minimality of the volume product at some polytopes. (Received September 03, 2012)

1084-52-279 **Daniel John Fresen*** (daniel.fresen@yale.edu). *A non-asymptotic central limit theorem.* Preliminary report.

We consider log-concave probability measures on Euclidean space of dimension at least two, with various regularity assumptions such as a smooth density function and independent coordinates. Another, more technical condition is imposed, that can be considered relatively mild. We show that the restriction of the density to an affine subspace of lower dimension far away from the origin tends to resemble the standard normal distribution, when appropriately normalized, provided the subspace is not parallel to a coordinate subspace. This phenomenon does not require high dimensionality, and works in both high and low dimensions. It can be thought of as a non-asymptotic counterpart to the classical central limit theorem, where the number of summands need not be large. (Received September 03, 2012)

1084-52-286 **Raeyong Kim*** (kimr@math.ohio-state.edu), 100 Math Tower 231 West 18th Avenue, Columbus, OH 43210-1174. *Algebraic Rank of* CAT(0) *Groups.*

Following Prasad and Raghunathan, the notion of the algebraic rank of a group will be introduced. I will describe results on algebraic rank of various CAT(0) groups. These include right-angled Coxeter groups, right-angled Artin groups and groups acting on CAT(0) spaces with isolated flats. As a corollary, we provide a partial answer to the question, posed by M. Davis, about the commensurability of Coxeter groups. (Received September 03, 2012)

1084-52-287 **Luis Rademacher*** (lrademac@cse.ohio-state.edu), Dreese Labs 495, 2015 Neil Ave., Columbus, OH 43210. *Simplicial polytopes that maximize the slicing constant are highly symmetric.*

The slicing 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 slicing constant as a function of the dimension. 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 show progress towards reducing to a highly symmetric case among non-smooth bodies. More precisely, we show that if a simplicial d-polytope K is a maximizer of the slicing constant among d-dimensional convex bodies, then when K is put in isotropic position it must be isohedral, that is, its symmetry group acts transitively upon facets. In particular, all facets are congruent. (Received September 03, 2012)

1084-52-290 **Felix Breuer*** (felix@fbreuer.de). *Ehrhart f^*-vectors and hypergraph coloring complexes.*

In recent years, Ehrhart theory has found a number of applications in combinatorics. The idea is to model combinatorial counting functions as Ehrhart functions of suitable geometric objects and then apply theorems from Ehrhart theory to obtain results. In this talk, we will examine the chromatic polynomial of hypergraphs from an Ehrhart perspective. This approach leads naturally to hypergraph coloring complexes. One interesting fact is that these complexes do not, in general, have a non-negative Ehrhart h^*-vector (or Ehrhart δ-vector), while their f^*-vector, on the other hand, is always non-negative. It turns out that this is no accident: Ehrhart f^*-vectors of polytopal complexes are always non-negative, even if the complex is non-convex and does not have a unimodular triangulation. Moreover, the f^*-coefficients of Ehrhart polynomials have a concrete counting interpretation. An interesting corollary is that this property characterizes Ehrhart polynomials of partial polytopal complexes: A polynomial is the Ehrhart polynomial of some partial polytopal complex if and only if its f^*-vector is non-negative. (Received September 04, 2012)

53 ► Differential geometry

1084-53-3 **Ben Weinkove*** (weinkove@math.ucsd.edu), 9500 Gilman Drive, 0112, La Jolla, CA 92093. *Parabolic flows in complex geometry.*

Parabolic flows are powerful tools in the study of geometric structures on manifolds. In this talk I will discuss some work (joint with Jian Song) on the behavior of the Ricci flow on Kahler manifolds. In particular, we analyze the singularities that form in complex dimension two and show how the flow can be continued through the singularities. I will also talk about some joint work with Valentino Tosatti on another parabolic flow, called the Chern-Ricci flow. This flow was first introduced by Matt Gill, and is a natural flow to consider on more general complex manifolds. I will discuss the behavior of this flow on complex surfaces, and give a number of examples. (Received August 07, 2012)

1084-53-46 **Mijia Lai*** (mijialai@gmail.com), 915 Hylan building, PO box 270138, Rochester, NY 14627. *On general inverse σ_k flow.*

I shall first introduce the general inverse σ_k flow which is a generalization of J-flow. Then I will focus on two types of convergence results. The first one is complete description of the convergence behavior on Kähler manifolds admitting metrics of Calabi ansatz. The second one is a boundary case for J-flow. Part of the work is joint with Hao Fang, Jian Song and Ben Weinkove. (Received August 13, 2012)

1084-53-56 **Mao-Pei Tsui*** (mao-pei.tsui@utoledo.edu), 2801 W. Bancroft St, Toledo, OH 43606. *Curvature Estimates for Higher Codimensional Mean Curvature Flow.* Preliminary report.

In this talk, I will discuss the curvature estimates for higher codimensional mean curvature flow. (Received August 15, 2012)

1084-53-86 **Tamas Darvas*** (tdarvas@math.purdue.edu), Department of Mathematics, Purdue University, 150 N. University Street, West Lafayette, IN 47907. *Morse theory and geodesics in the space of Kähler metrics.*

Given a compact Kähler manifold (X, ω_0) let $\mathcal{H}_0$ be the set of Kähler forms cohomologous to ω_0. As observed by Mabuchi, this space has the structure of an infinite dimensional Riemannian manifold, if one identifies it with a totally geodesic subspace of $\mathcal{H}$, the set of Kähler potentials of ω_0. Following Donaldson's research program, existence and regularity of geodesics in this space is of fundamental interest. In this paper, supposing enough regularity of a geodesic $u : [0, 1] \to \mathcal{H}$, connecting $u_0 \in \mathcal{H}$ with $u_1 \in \mathcal{H}$, we establish a Morse theoretic result relating the critical points of $u_1 - u_0$ to the critical points of $\dot{u}_0 = du/dt|_{t=0}$. As an application of this result, we prove that on all Kähler manifolds, connecting Kähler potentials with smooth geodesics is not be possible in general. In particular, in the case $X \neq \mathbb{C}P^1$, we will also prove that the set of pairs of potentials that can not be connected with smooth geodesics has nonempty interior. (Received August 23, 2012)

1084-53-106 **Ioana Suvaina***, 1326 Stevenson Center, Vanderbilt University, Nashville, TN 37240. *ALE Ricci-flat Kähler surfaces and weighted projective spaces.*

I will give an explicit classification of the ALE Ricci flat Kähler surfaces, generalizing previous classification results of Kronheimer. These manifolds are related to a special class of deformations of quotient singularities of type $\mathbb{C}^2/G$, with G a finite subgroup of $U(2)$.

I finish the talk by explaining the relations with the Tian-Yau construction of complete Ricci flat Kähler manifolds. (Received August 26, 2012)

1084-53-140 **Sean Holman*** (sfholman@math.purdue.edu), Purdue University, Department of Mathematics, 150 N. University Street, West Lafayette, IN 47906. *Recovery of a wave speed from the curvature of wavefronts.*

Imagine that we have an unknown wave speed $c(x)$ defined on a region X in Euclidean space and extended smoothly to all of $\mathbb{R}^n$. Suppose that we can measure outside of X the curvature of the wavefronts produced by point sources contained within X. From these data I will describe a completely constructive procedure to recover $c(x)$ within the region X. In dimension three or higher the method simply requires the solution of ordinary differential equations along the rays given by $c(x)$ and can therefore be localized. This talk is based on joint work with Maarten de Hoop, Einar Iversen, Matti Lassas, and Bjorn Ursin. (Received August 29, 2012)

1084-53-146 **Slawomir Dinew*** (slawomir.dinew@im.uj.edu.pl). *Hessian equations.*

We shall discuss recent progress on the complex Hessian equation. Both the local and the Kähler manifold setting will be considered.

This is a joint work with S. Kołodziej. (Received August 29, 2012)

1084-53-201 **Chris Connell*** (connell@indiana.edu) and **Pablo Suárez-Serrato** (p.suarez-serrato@matem.unam.mx). *Minimal and Simplicial Volume of Generalized Graph Manifolds.*

We examine certain smooth topological invariants and estimate, or in some cases compute, these for a general class of higher dimensional graph manifolds. The invariants we consider include minimal entropy, minimal volume, simplicial volume and the Yamabe invariant. (Received September 01, 2012)

1084-53-212 **Damin Wu*** (damin.wu@uconn.edu). *Heat kernel on Poincaré punctured disk.*

In this talk I will give an explicit formula for the heat kernel on Poincaré punctured disk. Then the formula is used to derive the Green's function on the quasi-projective manifold. We will apply the Green's function to study some canonical metrics on the quasi-projective manifolds. Part of my talk is based on an ongoing work joint with Xiaowei Wang. (Received September 02, 2012)

1084-53-213 **Andrew Martin Zimmer*** (aazimmer@umich.edu), Department of Mathematics, 2074 East Hall, 530 Church St, Ann Arbor, MI 48109. *Asymptotically harmonic manifolds.*

A complete Riemannian manifold without conjugate points is called asymptotically harmonic if the mean curvature of its horospheres is a universal constant. Examples of asymptotically harmonic manifolds include flat spaces and rank one locally symmetric spaces of noncompact type. In this talk we will describe some recent results concerning the classification of asymptotically harmonic manifolds. (Received September 02, 2012)

1084-53-263 **Matthew Gill*** (mfgill@math.berkeley.edu), Department of Mathematics, University of California, Berkeley, 970 Evans Hall #3840, Berkeley, CA 94720-3840. *The Chern-Ricci flow.*

We will discuss the Chern-Ricci flow, an analogue of the Kähler-Ricci flow on Hermitian manifolds. In particular, we will prove C^∞ convergence for the flow when the first Bott-Chern class is zero. (Received September 03, 2012)

54 ► General topology

1084-54-34 **Chuan Liu*** (liuc1@ohio.edu), Department of Mathematics, 1425 Newark Rd, Zanesville, OH 43701. *Generalized metric space properties in topology algebra.*

In this talk, we survey some recent results of generalized metric space properties on topological groups; paratopological groups and semitopological groups. We also discuss how the generalized metric space properties on remainders of Hausdorff compactification of a topological (paratopological, semitopological) group G affect the metrizability of G. Finally, we generalize several classic theorems of free topological groups on metrizable spaces to generalized metric spaces. Some questions are posed. (Received August 10, 2012)

1084-54-55 **Alireza Kamel Mirmostafaee***, Department of Pure Mathematics, Ferdowsi University of Mashad, Mashad, Korasan, Iran. *Points of continuity of quasi-continuous mappings into function spaces.*

Let X ba a Baire space, Y be a compact space and $f : X \to C_p(Y)$ be a quasi-continuous mapping. We will show that $f : X \to (C_p(Y), \|\cdot\|)$ is continuous on a dense G_δ subset of X, provided that in two related games on diagonal Δ of $Y \times Y$, one of the players doesn't have a winning strategy. (Received August 15, 2012)

1084-54-79 **I Namioka*** (namioka@math.washington.edu), University of Washington, Department of Mathematics, Box 354350, Seattle, WA 98195. *Separate versus joint continuity.*

Let X, Y, Z be topological spaces, and let $f : X \times Y \to Z$ be a map. The map f is said to be separately continuous if for each $a \in X$ the map $y \mapsto f(a, y)$ is continuous on Y, and for each $b \in Y$ the map $x \mapsto f(x, b)$ is continuous on X. The map f is said to be jointly continuous at $(a, b) \in X \times Y$ if it is continuous with respect to the product topology. Our general problem is: given a separately continuous map f as above, what can one say about the set C of all points in $X \times Y$ where f is jointly continuous ?. One can certainly not expect $C = X \times Y$ even in the simple case of $X = Y = Z = [0, 1]$.

In my talk I will describe what led me to this problem, what was known then, and finally how other mathematicians improved upon what I published in 1974. (Received August 22, 2012)

1084-54-173 **Ahmed Bouziad*** (ahmed.bouziad@univ-rouen.fr) and **Zbigniew Piotrowski** (zpiotrowski@ysu.edu). *On a problem of Z. Piotrowski.*

Our Talk is about the following problem of Z.Piotrowski: "Let Y be first countable, Z a metric space and let $f : X \times Y \to Z$ has all its x-sections continuous and all y-sections pointwise discontinuous. Suppose that $X \times Y$ is Baire. Is $C(f)$ a dense G_δ subset of $X \times Y$? What if X is Čech-complete?". (Received August 31, 2012)

1084-54-176 **Zbigniew Piotrowski***, Department of Mathematics & Statistics, Youngstown State University, Youngstown, OH 44555, and **R. Drozdowski** and **L. Hola**. *Joint quasi-continuity versus separate quasi-continuity.* Preliminary report.

For "nice" (e.g., second countable, Baire) spaces X and Y, separate quasi-continuity of *any* real-values function $f : X \times Y \to \mathbb{R}$ implies (joint) quasi-continuity. It is not hard to see that joint quasi-continuity need not imply quasi-continuity of all x-sections and y-sections. So, how many, in the sense of category, x-sections (respectively y-sections) must be quasi-continuous? This is a joint work with R. Drozdowski and L. Hola. (Received August 31, 2012)

1084-54-196 **Russell L Waller*** (rwaller@math.fsu.edu). *Baire and weakly Namioka spaces.*

Recall that a Hausdorff space X is said to be *Namioka* if for every compact (Hausdorff) space Y and every metric space Z, every separately continuous function $f : X \times Y \to Z$ is continuous on $D \times Y$ for some dense G_δ subset D of X. It is well known that in the class of all metrizable spaces, Namioka and Baire spaces coincide (Saint-Raymond, 1983). Further it is known that every completely regular Namioka space is Baire and that every separable Baire space is Namioka (Saint-Raymond, 1983).

In our paper we study spaces X, we call them *weakly Namioka*, for which the conclusion of the theorem for Namioka spaces holds provided that the assumption of compactness of Y is replaced by *second countability* of Y. We will prove that in the class of all completely regular separable spaces and in the class of all perfectly normal spaces, X is Baire if and only if it is weakly Namioka. Joint work with Zbigniew Piotrowski. (Received September 03, 2012)

1084-54-233 **Russell L Waller*** (rwaller@math.fsu.edu). *Separate continuity on lattices.* Preliminary report.

We look at separate continuity of lattice-valued functions defined on the product of lattices. In particular, we are interested in lattices in which the join and meet operators are separately continuous, and when such lattices are topological lattices. We also consider semilattices with separately continuous join or meet operations and their relation to topological semilattices, as well as topological semilattices with separately continuous join or meet operations and their relation to topological lattices. (Received September 03, 2012)

1084-54-283 **Ralph Kopperman*** (rdkcc@ccny.cuny.edu), Department of Mathematics, City College, New York, NY 10031, **Michael Bukatin** (bukatin@cs.brandeis.edu), Boston, MA , and **Steve Matthews** (steve.matthews@warwick.ac.uk), Department of Computer Science, University of Warwick, Coventry, UK, United Kingdom. *Finite approximation of topological spaces.*

While a topological space may have an infinite number of features (open sets), only a finite number can be seen a human or a computer program in finite time.

An ancient topology theorem says that each compact Hausdorff space is the subspace of closed points in an inverse limit of a system of finite T_0 spaces and continuous maps.

We discuss this result from a modern perspective and show how it handles the issues raised in our first paragraph. (Received September 03, 2012)

1084-54-292 **Steve Matthews*** (steve.matthews@warwick.ac.uk), Department of Computer Science, University of Warwick, Coventry, CV4 7AL, United Kingdom, **Michael Bukatin** (bukatin@cs.brandeis.edu), 4 Cambridge Center, 3rd Floor, Cambridge, MA MA 02142, and **Ralph Kopperman** (rdkcc@ccny.cuny.edu), 160 Convent Avenue, New York, NY NY '10031. *Topology and Logic.*

Let us take topology to be the study of mathematical properties preserved by continuous deformation, and logic to be the study of truth through deductive reasoning in a formal language. As continuity depends on the infinitary notion of limit, and deductions are finite, there seems to be little commonality between these subjects. But today's pervasive influence of computers in mathematics necessitates that topologists understand how continuous deformation is to be programmed, and conversely that computer programmers have more access to topology to model their computations. Today's talk will survey how topology & logic have been steadily

growing closer during the past century, and then present our own research upon developing a middle way for topology and logic. (Received September 04, 2012)

1084-54-302 **Jeffrey T. Denniston*** (jeffdenn@netzero.net). *Towards a notion of discontinuous function between topological systems.* Preliminary report.

This talk describes a functorial embedding $\Omega_{\mathbf{P}}$ of the category **TopSys** into itself. This embedding allows for a definition of "arbitrary function" between topological systems: a **TopSys** morphism between the corresponding images under $\Omega_{\mathbf{P}}$. An arbitrary function can be considered "continuous" if it is the image under $\Omega_{\mathbf{P}}$ of a continuous function. Further, the arbitrary functions between "spaces" according to this definition are in one-to-one correspondence with functions between the underlying sets. (Received September 04, 2012)

1084-54-353 **John P Dalbec*** (jdalbec132@aol.com), Computer Services, 414 MESH, Youngstown, OH 44555. *On a Theorem of Luzin.*

We generalize a result of Luzin about real functions of real variables–that $F(x, y)$ is jointly continuous if and only if $F(x, f(x))$ is continuous for every continuous f–to functions among certain classes of topological spaces. (published as "When does restricted continuity on continuous function graphs imply joint continuity?" Proc. Amer. Math. Soc. 118 (1993), 669-674) (Received September 04, 2012)

55 ► *Algebraic topology*

1084-55-58 **Ryan H Lewis*** (me@ryanlewis.net) and **Afra Zomorodian** (afra@cs.dartmouth.edu). *Multicore Homology.*

We design and implement a framework for parallel computation of homology of cellular spaces over field coefficients, by decomposing the space. Theoretically, we show that optimal decomposition into local pieces is NP-Hard. In practice, we achieve roughly an 8× speedup of homology computation on a 3-dimensional complex with about 10 million simplices using 11 cores. (Received August 15, 2012)

1084-55-64 **Justin M Curry*** (jucurry@math.upenn.edu), 209 South 33rd St., David Rittenhouse Laboratories, Philadelphia, PA 19104. *Cosheaves and Dualities in Generalized Sensor Networks.* Preliminary report.

In this talk, I will introduce the computational framework of cellular sheaves and cosheaves, and advocate for a different perspective on Morse Theory, persistent homology, network coding and pursuit-evasion problems in sensor networks. This framework provides local-to-global results as well as generalizations of Poincare duality. To provide concrete examples, I will introduce a new model for sensing with different modalities (colors, sounds, etc.) and show how a long exact sequence of sheaf cohomology provides forcing results that allow you to infer what you don't know from what you do. (Received August 19, 2012)

1084-55-91 **Peter Bubenik** and **Jonathan Scott*** (j.a.scott3@csuohio.edu), Cleveland State University, Department of Mathematics, 2121 Euclid Ave, RT 1515, Cleveland, OH 44115-2214. *Categorification of Persistent Homology.*

We redevelop topological persistence (persistent homology) from a categorical point of view. The main objects of study are $(\mathbf{R}, \leq)$-indexed diagrams in some target category. The set of such diagrams has an *interleaving* distance, which we show generalizes the previously-studied bottleneck distance. To illustrate the utility of this approach, we generalize previous stability results for persistence, extended persistence, and kernel, image and cokernel persistence.

We give a natural construction of a category of ε-interleavings of $(\mathbf{R}, \leq)$-indexed diagrams in some target category, and show that if the target category is abelian, so is this category of interleavings. (Received August 24, 2012)

1084-55-168 **Anil N. Hirani*** (hirani@illinois.edu), Department of Computer Science, 201 N. Goodwin Ave., Urbana, IL 61801. *Applied Topology and Matrix Methods.*

This talk is a survey of matrix methods for efficient numerical computation of Hodge decomposition and discrete harmonic forms (i.e. harmonic cochains) in a variety of settings for a variety of applications. These include comparisons of methods for least squares based ranking on graphs, computation of harmonic cochains for hole localization on Vietoris-Rips complex idealization of sensor networks, and comparison of harmonic forms computation on manifold complexes using eigenvector methods and least squares methods. (Received August 31, 2012)

1084-55-277 **Yuriy Mileyko*** (ymileyko@lavabit.com), Coordinated Science Laboratory, 1308 West Main St., Urbana, IL 61801, and **John Harer**. *Reincarnations in persistent homology with application to shape skeleta.*

The theory of persistent homology relies heavily on the existence of birth-death decompositions of persistence modules. The latter are sequences of vector spaces (indexed by integers or real numbers) connected by linear maps. It is important to note that the existence the birth-death decomposition is indifferent to the fact that a persistence module typically represents the (co)homology of a sequence of nested spaces, which is often obtained by using excursion sets of a continuous function. In this talk we show that by employing exact sequences and cap/cup products in homology and cohomology we can create an additional structure on top of the birth-death decompositions which relates deaths of (co)homology in one dimension with births in a different dimensions. This leads to the concept of a reincarnation. We show that reincarnations can be very useful when studying excursion sets of a family of functions. In particular, we use reincarnations to provide an alternative definition of the medial axis, curve skeleton, and even higher order skeleta. (Received September 03, 2012)

1084-55-309 **Paul Bendich*** (bendich@math.duke.edu), **Jacob Harer** and **John Harer**. *A Persistent Homology Based Geodesic Distance Estimator for Dimesion Reduction.*

Given a point cloud sampled from or near a Riemannian manifold embedded in high-dimensional Euclidean space, one often wants to build a metric on the point cloud which approximates the geodesic metric on the manifold M. In this paper, we prove theoretical guarantees for the quality of standard graph geodesic metric constructions. We also present a novel algorithm which uses persistent homology to build such a metric, and provide experimental evidence that it is more accurate than other constructions. Finally, we discuss the improvements our algorithm offers to the non-linear dimension reduction technique IsoMap. (Received September 04, 2012)

1084-55-348 **Andrew J Blumberg***, blumberg@math.utexas.edu, and **Itamar Gal**, **Michael A. Mandell** and **Mathew Pancia**. *Persistent Homology for Metric Measure Spaces and Topological Hypothesis Testing.*

This talk describes work studying the use of distributions of persistent homology barcodes associated to taking subsamples of a fixed size from metric measure spaces. Such distributions can be efficiently computed and provide robust invariants of metric measure spaces. These invariants also supply a basis for applying standard statistical methodology to problems in topological data analysis. (Received September 04, 2012)

1084-55-357 **yuliy baryshnikov*** (ymb@uiuc.edu). *Space of coverings.* Preliminary report.

I will introduce the space of /*epsilon*-networks in a metric space XZ and describe some of its properties. (Received September 04, 2012)

57 ► Manifolds and cell complexes

1084-57-2 **Tim D Cochran*** (cochran@rice.edu), MS-136 Math. department, PO Box 1892, Houston, TX 77251-1892. *Knots, 4-dimensions and fractals.*

A knot is an embedded circle in $\mathbb{R}^3$. It is called a *slice knot* if it is the intersection of an embedded S^2 in $\mathbb{R}^4$ with $\mathbb{R}^3 \subset \mathbb{R}^4$. Using this notion, one can define an equivalence relation on knots called *concordance*. Moreover, the set of equivalence classes forms an abelian group called the *knot concordance group*. This group plays an important role in the study of 3- and 4-dimensional manifolds. In this talk, we will give a historical overview of knot concordance and also describe some new work as described below.

We will define a new filtration of the knot concordance group (joint with Harvey and Horn), called the *bipolar filtration*. This is a refinement of the *solvable filtration* defined by Cochran-Orr-Teichner in the late 90's. Unlike the solvable filtration, the bipolar filtration restricts to give a non-trivial filtration on an important subgroup of the knot concordance group called the group of *topologically slice* knots.

Finally, we discuss how this group of concordance classes can be viewed as a *fractal space*. (Received September 03, 2012)

1084-57-48 **Matthew Hedden*** (mhedden@math.msu.edu), East Lansing, MI 48823, and **Liam Watson**. *On the geography and botany of Floer homology.*

I'll survey some of what is known about the realization (geography) and faithfulness (botany) questions for Floer homology. The first asks: given a group, which knots or 3-manifolds have this group as their Floer invariants? The second asks: if a group is realized as the Floer homology of some knot or manifold, how many other knots or manifolds are there with the same invariants? (Received August 13, 2012)

1084-57-50 **Joshua Batson*** (batson@mit.edu). *Nonorientable four-ball genus can be arbitrarily large.*
The nonorientable four-ball genus of a knot K is the smallest first Betti number of any smoothly embedded, nonorientable surface F in B^4 bounding K. In contrast to the orientable four-ball genus, which is bounded below by the Murasugi signature, the Ozsvath-Szabo tau-invariant, and the Rasmussen s-invariant, the best lower bound in the literature on the nonorientable four-ball genus for any K is 3. We find a lower bound in terms of the signature of K and the Heegaard-Floer d-invariant of the integer homology sphere given by -1 surgery on K. In particular, we prove that the nonorientable four-ball genus of the torus knot $T(2k, 2k-1)$ is $k-1$. (Received August 14, 2012)

1084-57-54 **Michael Robinson***, 226 Gray Hall, American University, Washington, DC 20016. *The Whitney embedding theorem in signal processing.*
When can you infer the state of a system from measurements of a signal? In a surprisingly diverse set of situations, rather precise bounds can be obtained on the number of measurements needed to constrain a system from the Whitney embedding theorem. This result of differential topology is easy to state, easy to use, and intuitively satisfying. I will discuss its mathematical importance and advocate for its wider application within engineering. Its effectiveness within the context of opportunistic localization, navigation, and other example areas will be discussed. (Received August 14, 2012)

1084-57-68 **R. Taylor McNeill*** (rtm2@rice.edu). *A new filtration of the Magnus kernel of the Torelli group.*
For a surface Σ, the Torelli group is the group of orientation preserving homeomorphisms of Σ that induce the identity on homology. The Magnus representation represents the action on F/F'' where $F = \pi_1(\Sigma)$ and F'' is the second term of the derived series. For many years it was unknown whether the Magnus representation of the Torelli group is faithful. In recent years there have been many developments on this front including the result of Church and Farb that the kernel of the Magnus representation, denoted K, is infinitely generated. I show that, not only is K highly non-trivial but that it also has a rich structure as a group. Specifically, I define an infinite filtration of K by subgroups, called the higher order Magnus subgroups, M_n. I show that for each n the quotient M_n/M_{n+1} is infinitely generated. To do this, I define a Johnson type homomorphism on each higher order Magnus subgroup quotient and show it has a highly non-trivial image. (Received August 20, 2012)

1084-57-71 **Tim D Cochran** and **Peter D Horn*** (pdhorn@syr.edu), Department of Mathematics, Syracuse University, 215 Carnegie Building, Syracuse, NY 13244-1150. *Topologically slice knots and bipolarity.*
Cochran, Harvey and the speaker introduced the *bipolar filtration* of the knot concordance group to organize the study of the group of topologically slice knots, $\mathcal{T}$. The filtration is decreasing $\mathcal{T} \supset \mathcal{T}_0 \supset \mathcal{T}_1 \supset \cdots \supset \mathcal{T}_n \supset \mathcal{T}_{n+1} \supset \cdots \supset \{0\}$. A knot which can be unknotted by certain crossing changes lies in $\mathcal{T}_0$ – the group of so-called 0-bipolar knots – though these examples do not account for all 0-bipolar knots. The concordance invariants s and τ from Khovanov and Heegaard Floer homology must vanish for any 0-bipolar knot. Using d-invariants from Heegaard Floer homology, we show that the quotient group $\mathcal{T}_0/\mathcal{T}_1$ has infinite rank. (Received August 21, 2012)

1084-57-81 **Charles Livingston*** (livingst@indiana.edu) and **Se-Goo Kim** (sgkim@khu.ac.kr). *Splitting the 3-dimensional rational homology cobordism group.*
Associated to each rational homology 3-sphere there is a linking form defined on its first homology. This induces a homomorphism from the 3-dimensional rational homology cobordism group to the Witt group of non-degenerate symmetric Q/Z-valued bilinear forms on finite abelian groups. This Witt group splits naturally as a direct sum over the prime integers. In this talk I will discuss the failure of this splitting to be reflected in the cobordism group. (Received August 23, 2012)

1084-57-83 **Arunima Ray*** (arunima.ray@rice.edu). *Slice knots which bound Klein bottles.*
We investigate the properties of knots in $\mathbb{S}^3$ which bound Klein bottles, such that a pushoff of the knot has zero linking number with the knot, i.e. has *zero framing*. This is motivated by the many results in the literature regarding slice knots of genus one, for example, the existence of homologically essential zero self-linking simple closed curves on genus one Seifert surfaces for algebraically slice knots. Given a knot K bounding a (punctured) Klein bottle F with zero framing, we show that J, the core of the orientation-preserving band in any disk-band form of F, has zero self-linking. We prove that such a K is slice in a $\mathbb{Z}\left[\frac{1}{2}\right]$-homology $\mathbb{B}^4$ if and only if J is as well, a stronger result than what is currently known for genus one slice knots. As an application, we prove that given knots K and J and any odd integer p, the $(2, p)$ cables of K and J are $\mathbb{Z}\left[\frac{1}{2}\right]$-concordant if and only if K

and J are $\mathbb{Z}\left[\frac{1}{2}\right]$-concordant. In particular, if the $(2,1)$-cable of a knot K is slice, K is slice in a $\mathbb{Z}\left[\frac{1}{2}\right]$-homology ball. (Received August 23, 2012)

1084-57-89 **Eamonn P Tweedy*** (eamonn@rice.edu) and **Tim D Cochran**. *Zero-positivity of two-component links.*

Cochran, Harvey, and Horn defined the notion of a zero-positive knot, which generalizes sliceness in a signed way. Here I'll discuss joint work with Tim Cochran, in which we study an analogous property for two-component links with linking number equal to zero. We'll describe how zero-positivity for such links relates to the Sato-Levine invariant and coefficients of the Conway polynomial. (Received August 24, 2012)

1084-57-90 **Stefan Friedl***, Universitaet zu Koeln, Mathematisches Institut, 50931 Koeln, Germany. *Complexity of surfaces in 4-manifolds with a free circle action.*

For most closed 3-manifolds we will determine the minimal complexity of surfaces representing homology classes in most circle bundles over the given 3-manifold. This is joint work with Stefano Vidussi. (Received August 24, 2012)

1084-57-98 **Elmas Irmak*** (eirmak@bgsu.edu), Ann Arbor, MI. *Simplicial Maps of the Complexes of Curves of Nonorientable Surfaces.*

Let N be a compact, connected, nonorientable surface of genus g with n boundary components, and $\mathcal{C}(N)$ be the complex of curves of N. Suppose that $g+n \leq 3$ or $g+n \geq 5$. If $\lambda : \mathcal{C}(N) \to \mathcal{C}(N)$ is an injective simplicial map, then λ is induced by a homeomorphism of N. If $(g,n) \neq (1,2)$ and λ satisfies the connectivity property, then λ is induced by a homeomorphism of N. (Received August 25, 2012)

1084-57-126 **Maciej Borodzik*** (mcboro@mimuw.edu.pl), Banacha 2, 02-097 Warsaw, Poland. *Algebraic unknotting and 4-manifolds.*

We prove that if the algebraic unknotting number of K is n, then is the zero-surgery on the knot is the boundary of a topological 4-dimensional manifold with specific homological properties and $b_2 = n$. We sketch also prove of the converse result, giving the full interpretation of the algebraic unknotting number in the language of 4-dimensional topology. This is joint work with. S. Friedl. (Received August 28, 2012)

1084-57-130 **Matthew Stover*** (stoverm@umich.edu), Department of Mathematics, 530 Church Street, Ann Arbor, MI 48109. *Ends of hyperbolic n-manifolds.*

Let M be a compact n-manifold with nonempty boundary consisting of a disjoint union of tori. When does the interior of M admit a complete hyperbolic metric of finite volume? When n is 2 or 3, one can give a very satisfying answer to this question based entirely on the topological type of M. For $n \geq 4$, the situation remains far more mysterious. For example, there is no known example of a 1-ended finite volume hyperbolic n manifold for any $n \geq 4$, and orbifolds were only known previously for $n \leq 9$. I will discuss the proof of the following theorem: 1-ended arithmetic hyperbolic n-orbifolds do not exist for $n \geq 30$. This is a consequence of a more general result, namely, that for any fixed $k > 0$, the number of arithmetic negatively curved locally symmetric spaces N with $e(N) = k$ fall into finitely many commensurability classes. (Received August 28, 2012)

1084-57-152 **Frank Connolly**, **James F Davis** and **Qayum Khan*** (qkhan@indiana.edu). *Rigidity of pseudo-free group actions on contractible manifolds.*

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

If Γ has no elements of order two, then we obtain equivariant topological rigidity of the pair (X, Γ). Hence, if Γ is torsion-free, then we generalize a recent theorem of A. Bartels and W. Lück, which validates the classical Borel Conjecture for CAT(0) fundamental groups. Otherwise, if Γ has elements of order two, we show how to parameterize all possible counter-examples, in terms of Cappell's UNil summands of the L-theory of infinite dihedral groups. In certain cases, these are detected along hypersurfaces in the orbifold X/Γ by generalized Arf invariants. (Received August 29, 2012)

1084-57-162 **Jennifer Hom*** (hom@math.columbia.edu), **Sam Lewallen**, **Tye Lidman** and **Liam Watson**. *Bordered Floer homology and the Seifert form.* Preliminary report.

We study the bordered Floer homology of the 3-manifold with boundary obtained by cutting S^3 along a Seifert surface Σ for a knot K. In particular, we show that this bordered invariant is a categorification of the Seifert

form. This is joint work in progress with Sam Lewallen, Tye Lidman and Liam Watson. (Received August 30, 2012)

1084-57-165 **Daniel Ruberman*** (ruberman@brandeis.edu), Department of Mathematics, MS 050, Brandeis University, Waltham, MA 02454, and **Hee Jung Kim** (heejungorama@gmail.com), Hyoja-Dong San 31, Nam-Gu, Pohang, Gyungbuk 790-784, South Korea. *Slice versus ribbon for some fibered knots.* Preliminary report.

In 1983, Casson and Gordon showed that a fibered ribbon knot has monodromy that (when capped off) extends over a handlebody. Shortly afterwards, Bonahon gave an infinite collection of genus 2 fibered knots K_n, and analyzed the cobordism classification of their monodromies. As a consequence, he showed (via the Casson-Gordon result) that $K_m\# -K_n$ is ribbon if and only if $m = n$. We investigate whether these knots can be slice, as a test of the 'slice implies ribbon' conjecture, and show that $K_m\# -K_0$ is slice if and only if $m = 0$. (Received August 30, 2012)

1084-57-177 **Carolyn A Otto*** (ottoa@uwec.edu). *Filtrations of the Link Concordance and Milnor's Invariants.*

We establish results about the (n)-solvable filtration, $\{\mathcal{F}_n^m\}$, of the string link concordance group which also holds for link concordance. Previously, there were no known results about the "other half" of the filtration, namely $\mathcal{F}_{n.5}^m/\mathcal{F}_{n+1}^m$. We first establish a relationship between (n)-solvability of a link and its Milnor's $\overline{\mu}$-invariants. Using results we proved about the effects of the Bing doubling operator on (n)-solvability, we show that $\mathcal{F}_{n.5}^m/\mathcal{F}_{n+1}^m$ is nontrivial for links with sufficiently many components. We also find a similar relationship between the Grope filtration, $\{\mathcal{G}_n^m\}$, of the string link concordance group and Milnor's invariants and use it to show that this filtration is not the same as the (n)-solvable filtration. Lastly, we will discuss the relationship between Milnor's invariants and other recently defined filtrations of link concordance. (Received August 31, 2012)

1084-57-178 **Christopher William Davis*** (davis.3929@osu.edu) and **Tim Cochran**. *Slice knots with non-slice derivatives.* Preliminary report.

In his book, On Knots, Kauffman posed the conjecture that if a knot is slice then on any Seifert surface for that knot there will exist a curve of self linking zero which is slice. In the topological category, counterexamples to this conjecture exist due to the result of Freedman that a knot with trivial Alexander polynomial is topologically slice. There are many result in the literature which suggest that if one works in the smooth category and considers knots with nontrivial Alexander polynomial then this conjecture may be true. In this talk we find examples of knots which are smoothly slice in a possibly exotic 4-ball, which have nontrivial Alexander polynomial, and which have Seifert surfaces for which there is not even a curve of self linking zero that has vanishing Arf-invariant. We present some progress in showing that these knots are smoothly slice in the 4-ball with its usual smooth structure. (Received August 31, 2012)

1084-57-181 **John R. Burke*** (jburke@ric.edu). *Knots are not enough but string links are.*

In this talk, we will discuss the structure of the concordance group of knots. In particular, we will discuss results about the structure of the quotient groups, G_n, of n-solvable knots modulo $n.5$-solvable knots. We will describe sets of knots in G_n which arise from genetic infection of knots by string links. These knots are linearly independent from all previously studied knots in G_n. The talk will aim to show the importance of string link concordance in the study of knot concordance. (Received August 31, 2012)

1084-57-183 **Joshua Evan Greene***, Boston College, Department of Mathematics, Chestnut Hill, MA 02467. *Quasi-alternating links.*

I will discuss what I know concerning quasi-alternating links, which form an interesting generalization of alternating links. The main result is jointly due to Liam Watson: we show that an infinite family of knots occurring in work of Kanenobu are not quasi-alternating, even though their homological invariants are thin and isomorphic. To show that they are not quasi-alternating uses some facts about 4-manifolds. (Received August 31, 2012)

1084-57-187 **Adam Simon Levine*** (levinea@brandeis.edu), **Daniel Ruberman** (ruberman@brandeis.edu) and **Saso Strle** (saso.strle@fmf.uni-lj.si). *Embeddings of non-orientable surfaces in $L(p,q) \times I$.* Preliminary report.

We use Heegaard Floer homology correction terms to study embeddings of non-orientable surfaces into $L \times I$, where L is a homology lens space. If a non-orientable surface S embeds into $L \times I$ and represents the nontrivial element of $H_2(L \times I; \mathbb{Z}/2)$, we show that the differences between the d-invariants of certain spin^c structures on L are bounded by the d-invariants of the unit normal bundle of S. Using this approach, we show that if L is a lens space for which $\mathbb{R}\mathrm{P}^3$ embeds into $L \times I$, then $L \cong L(2,1)$. (Received August 31, 2012)

1084-57-204 **Mark Powell*** (macp@indiana.edu), Rawles Hall, 831 E 3rd street, Bloomington, IN 47405. *Algebraic surgery on 4 manifolds.* Preliminary report.

I will discuss joint work in progress with Kent Orr in which we develop a programme to apply the algebraic surgery machine of Andrew Ranicki to 4 manifolds, producing new invariants of knot concordance. (Received September 01, 2012)

1084-57-215 **James F Davis***, Department of Mathematics, Indiana University, Bloomington, IN 47405, and **Fuquan Fang**. *Almost flat manifolds with cyclic holonomy groups bound.*

Farrell and Zdravkovska conjectured that an almost flat manifold is a boundary. We use flat bundles and characteristic classes to prove this conjecture for almost flat manifolds with cyclic holonomy group. (Received September 02, 2012)

1084-57-224 **Jae Choon Cha*** (jccha@postech.ac.kr). *Symmetric Whitney tower cobordism for bordered 3-manifolds.*

I will discuss a symmetric Whitney tower approach to the study of homology cobordism of bordered 3-manifolds, and extend Cha-Orr's amenable L^2-signature theorem. This generalizes several previously known cases. If time permits, I will talk about some new applications, particularly results on (Whitney tower and grope) concordance of links with linking number one. (Received September 02, 2012)

1084-57-255 **Craig R Guilbault*** (craigg@uwm.edu), Department of Mathematical Sciences, University of Wisconsin-Milwaukee, Milwaukee, WI 53201, and **Frederick C Tinsley** (ftinsley@coloradocollege.edu), Department of Mathematics and Computer Scienc, Colorado College, Colorado Springs, CO 80903. *End structures and boundaries for open manifolds.* Preliminary report.

For a one-ended open manifold, the simplest end structure one can hope for is an open collar neighborhood of infinity; that is, a codimension 0 manifold neighborhood of infinity U homeomorphic to $\partial U \times [0, \infty)$. Characterizing "collarable" manifolds was the topic of L.C. Siebenmann's famous thesis from 1965.

In a series of papers we developed a weaker notion, called a pseudocollar, which is rigid enough to provide some useful structure, but flexible enough to be applicable to more complicated manifolds. Ultimately that effort yielded a set of three necessary and sufficient conditions for a high-dimensional open manifold to be pseudocollarable. In this talk we will discuss properties possessed by manifolds satisfying a subset of those conditions. An ultimate goal is to determine when an open manifold admits a $\mathcal{Z}$-set compactification. An interesting aspect of this work is the subtantial role played by group theory. (Received September 03, 2012)

1084-57-278 **Boris Okun*** (okun@uwm.edu) and **Richard Scott**. *On Atiyah Conjecture for right-angled Hecke–von Neuman Algebras.*

Given an action of a Coxeter group on a space, one can define so-called weighted L^2-cohomology of the space. Depending on the weights, this theory interpolates between the compactly supported cohomology, the L^2-cohomology, and the usual (infinitely supported) cohomology. Moreover, in this situation, one can also define the weighted L^2-Betti numbers, which turn out to be continuous functions of weights. A version of the Strong Atiyah Conjecture predicts possible values of these numbers. We prove it for a dense subset of rational weights for right-angled groups. (Received September 03, 2012)

1084-57-307 **Fuquan Fang*** (fuquan_fang@yahoo.com), Notre Dame, IN 46545, **Karsten Grove**, Notre Dame, IN 46545, and **Gudlaugur Thorbergsson**. *Tits Geometry and Positive Curvature.*

There is a well known link between (maximal) irreducible polar representations and isotropy representations of irreducible symmetric spaces provided by Dadok. Moreover, the theory by Tits and Burns - Spatzier provides a link between irreducible symmetric spaces of non-compact type of rank at least three and compact topological spherical irreducible buildings of rank at least three.

We discover and exploit a rich structure of a (connected) chamber system of finite (Coxeter) type M associated with any polar action of cohomogeneity at least two on any simply connected (closed) positively curved manifold. Although this chamber system is typically not a (Tits) geometry of type M, we prove that in all cases but one that its universal (Tits) cover indeed is a building. We construct a topology on this universal cover making it into a compact topological building in the sense of Burns and Spatzier.

We use this structure to prove the following rigidity theorem:

Any polar action of cohomogeneity at least two on a simply connected positively curved manifold is smoothly equivalent to a polar action on a rank one symmetric space. (Received September 04, 2012)

1084-57-321 **Shelly Harvey*** (shelly@rice.edu) and **Danielle O'Donnol**. *Combinatorial Spatial Graph Floer Homology.*

A spatial graph is an embedding, f, of a graph G into S^3. For each balanced and oriented spatial graph with a transverse disk, $f(G)$, we define a combinatorial invariant $HFG(f(G))$ which is a bi-graded module over a polynomial ring in V variables, where V. The gradings live in $\mathbb{Z}$ and $H_1(S^3 \setminus f(G))$. This invariant is a generalization of combinatorial link Floer homology defined by Manolescu, Ozsvath, Sarkar (MOS) for links in S^3. To do this, we define a grid diagram for each such spatial graph and show that every embedding can be put into grid form. Following MOS, our invariant is the homology of a chain complex that counts certain rectangles in the grid. Although the chain complex depends on the choice of grid, the homology depends only on the embedding. We also define an Alexander polynomial for this type of spatial graph and show it can be obtained as the graded Euler characteristic of $HFG(f(G))$. This is joint work with D anielle O'Donnol (Imperial College London). (Received September 04, 2012)

1084-57-322 **Taylor E Martin*** (taylor.martin@rice.edu). *Classification of 0-solvable links and results about 0.5-solvability.*

The n-solvable filtration, defined by Cochran, Orr, and Teichner in the late 90's, gives structure to the smooth knot and link concordance groups. Much is known about the n-solvable filtration of the knot concordance group for small n. For example, a knot is 0-solvable if and only if it has Arf invariant zero. Moreover, a knot is 0.5-solvable precisely when it's Seifert matrix looks like that of a slice knot, called algebraically slice. However, very little is known for links. In this talk, we will completely classify 0-solvable links and discuss recent progress towards understanding 0.5-solvable links. (Received September 04, 2012)

1084-57-352 **Jim Fowler*** (fowler@math.osu.edu) and **Zhixu Su** (zhixus@uci.edu). *Manifolds realizing rational homotopy types.*

Computing coefficients of the Hirzebruch L-polynomials can be slow. A recursive method is quick enough to find many coefficients for our particular application: by solving certain Diophantine equations with these coefficients, we produce manifolds having a truncated polynomial algebra as their rational cohomology ring. Such manifolds may exist even when the corresponding truncated polynomial over $\mathbb{Z}$ is not the cohomology ring of any space. As a specific example, there is a manifold having the rational cohomology that $\mathbb{O}P^4$ would be expected to have, if it existed. (Received September 04, 2012)

58 ► Global analysis, analysis on manifolds

1084-58-250 **David A. Sher*** (davidsher13@gmail.com), Dept. of Math. and Stat., McGill University, Burnside Hall, Room 1005, 805 Sherbrooke Street West, Montreal, Quebec H3A 0B9, Canada. *The determinant on conic surfaces with excision of disks.* Preliminary report.

Let (M, g) be a surface with a flat conical metric, and consider the surface M_ϵ obtained by removing disks of radius ϵ around any subset of the conical singularities. We investigate the asymptotic behavior of the determinant of the Laplacian on M_ϵ, with Dirichlet boundary conditions, as ϵ approaches zero. Such families of metrics have been studied by Khuri in the context of the Osgood-Phillips-Sarnak approach to isospectral compactness; Khuri used these metrics to prove that the determinant of the Laplacian is not a proper map on the moduli space of surfaces of genus p with n disks removed for $np \geq 1$. We sharpen and generalize her results; our main formula is an asymptotic expansion for the determinant as ϵ goes to zero, up to terms which vanish in the limit. A key step in the proof is the adaptation of an argument of Wentworth which enables us to compute the asymptotics of the determinant of the Dirichlet-to-Neumann operator on M_ϵ. (Received September 03, 2012)

1084-58-253 **Suresh Eswarathasan*** (suresh@math.mcgill.ca), McGill University, Department of Mathematics, Burnside Hall, Montreal, QC H3A 0B9, and **Iosif Polterovich** and **John Toth**. *Lower bounds for the Weyl remainder on Euclidean domains.*

The remainder term $R(\lambda)$ for the spectral counting function $N(\lambda)$ likely encodes a great deal of dynamical information for the system at hand. For $\Omega \subset \mathbb{R}^n$, a piecewise smooth bounded domain, we prove an omega bound that depends on the dimension of the fixed point set of the billiard map; the approach taken is through boundary trace expansions. This is the first lower bound established in settings with boundary, at least to the knowledge of the authors. As a corollary, $R(\lambda)$ for the Bunimovich stadium is $\Omega(\lambda^{1/2})$. (Received September 03, 2012)

1084-58-306 **Kiril Datchev***, 77 Mass Ave, Cambridge, MA 02139, and **Semyon Dyatlov**. *Fractal Weyl laws for asymptotically hyperbolic manifolds.*

For asymptotically hyperbolic manifolds with hyperbolic trapped sets we prove a fractal upper bound on the number of resonances near the essential spectrum, with power determined by the dimension of the trapped set. This covers the case of general convex cocompact quotients (including the case of connected trapped sets) where our result implies a bound on the number of zeros of the Selberg zeta function in disks of arbitrary size along the imaginary axis. Although no sharp fractal lower bounds are known, the case of quasifuchsian groups, included here, is most likely to provide them. This project is joint work with Semyon Dyatlov. (Received September 04, 2012)

60 ► Probability theory and stochastic processes

1084-60-14 **Parisa Fatheddin*** (fatheddin@math.utk.edu), 227 Ayres Hall, 1403 Circle Drive, Knoxville, TN 37996-1320, and **Jie Xiong** (jxiong@math.utk.edu), 227 Ayres Hall, 1403 Circle Drive, Knoxville, TN 37996-132. *Large and Moderate Deviations for Some Measure-Valued Processes.* Preliminary report.

In this talk we derive the Large and Moderate Deviation Principles for two important population models: super-Brownian motion and Fleming-Viot Process. We do so by considering an Stochastic Differential Equation (SPDE) of the form,

$$u_t^\epsilon(y) = F(y) + \sqrt{\epsilon}\int_0^t \int_U G(a, y, u_s^\epsilon(y))W(dsda) + \int_0^t \frac{1}{2}\Delta u_s^\epsilon(y)dy$$

where F is a function on $\mathbb{R}$ and $G : U \times \mathbb{R}^2 \to \mathbb{R}$ is a non-lipschitz coefficient. This SPDE can be used to represent our models. (Received June 28, 2012)

1084-60-57 **Elizabeth Meckes*** (ese3@case.edu). *Projections of probability measures: a measure-theoretic Dvoretzky theorem.*

Dvoretzky's theorem tells us that if we put an arbitrary norm on n-dimensional Euclidean space, then by passing to subspaces of dimension about log(n), that arbitrary norm looks almost Euclidean itself. A related measure-theoretic phenomenon has long been observed: the (one-dimensional) marginals of many natural high-dimensional probability distributions are approximately Gaussian. A question which had received little attention until recently is whether this phenomenon persists for k-dimensional marginals for k growing with n, and if so, for how large a k? In this talk I will discuss recent work showing that the phenomenon persists if k is of the order log(n)/log(log(n)), and that this bound is sharp. (Received August 15, 2012)

1084-60-206 **Kiseop Lee***, kiseop.lee@louisville.edu, and **Wanmo Kang**. *Information on Jump Sizes and Hedging.*

We study a hedging problem in a market where are traders with different levels of infor- mation. The exclusive information available only to informed traders is modeled by a diffusion process rather than discrete arrivals of information. The asset price follows a stochastic process with jumps and the information process affects jump sizes of the asset price. We find the local risk minimization hedging strategy of informed traders. Numerical examples are provided using simulated data. (Received September 01, 2012)

1084-60-223 **Omer Bobrowski***, omer@math.duke.edu. *How Noise Crackles.*

We study the topology of random Čech complexes with a fixed parameter, generated by $n \to \infty$ iid samples from distributions with unbounded supports in Euclidean space. We observe that there exists a 'core', i.e., a region where the random samples are very dense, so that placing unit balls around the individual points completely covers the region. Consequently, the Čech complex inside the core is contractible. The size of the core obviously grows as $n \to \infty$. Outside the core there may be additional isolated points, but not enough for the associated balls to cover the entire area. Thus, in this region, the topology of the Čech complex is nontrivial, and many holes of different dimensions might show up. We call this phenomenon 'crackling'. In this talk we compare the crackling behavior of three representative distributions - the power law, exponential and Gaussian.

The motivation for this study comes from topological manifold learning problems. The results we present suggest in the presence of noise, increasing the number of samples does not necessarily guarantee increased accuracy of homology recovery.

This is joint work with Robert Adler and Shmuel Weinberger. (Received September 02, 2012)

1084-60-226 **Omer Bobrowski** and **Matthew Strom Borman*** (borman@math.uchicago.edu). *Euler integration of Gaussian random fields and persistent homology.*

In this talk I will present a simple formula for the expected Euler integral of a Gaussian random field and related expectations, which are derived from the Gaussian kinematic formula. Using the relationship between the Euler integral and persistent homology, this amounts to an explicitly computable mean of a quantitative descriptor for the persistent homology of a Gaussian random field. (Received September 02, 2012)

1084-60-294 **Barbara Margolius*** (b.margolius@csuohio.edu), Dept Mathematics, RT1515, 2121 Euclid Ave, Cleveland, OH 44115-2214. *Quasi-Birth-and-Death-Processes with time-varying periodic rates.*

Queues with time-varying rates have been considered in the literature at least since Kolmogorov considered the waiting problem in a paper in 1931 [Sur le probleme d'attente, On the Problem of Waiting]. Motivating applications for queues with time-varying parameters have included airport congestion, police calls for service, call centers, streaming and data traffic in a multiserver network, traffic congestion, demand for health care and many others. In this talk, we focus on systems with time-varying periodic parameters. We consider quasi-birth-and-death processes (QBD) with time-varying periodic rates. These results put the time-varying periodic QBD in the context of matrix analytic methods. We follow the approach laid out in LaTouche and Ramaswami's *Introduction to Matrix Analytic Methods in Stochastic Modeling* (the red book), generalizing it to the time-varying case. The approach requires the numerical solution of an integral equation over one time period. (Received September 04, 2012)

1084-60-311 **Dan Cheng*** (cheng@stt.msu.edu), 619 Red Cedar Road Rm C413, Department of Statistics and Probability, Michigan State University, East Lansing, MI 48824, and **Yimin Xiao**. *The Mean Euler Characteristic and Excursion Probability of Gaussian Random Fields with Stationary Increments.*

Let $X = \{X(t) : t \in \mathbb{R}^N\}$ be a centered smooth Gaussian random field with stationary increments, we derive a formula for computing $\mathbb{E}\{\varphi(A_u)\}$, the mean Euler characteristic of the excursion set $A_u = \{t \in T : X(t) \geq u\}$, where T is a rectangle. Using Rice method, we show that for large u, the excursion probability $\mathbb{P}\{\sup_{t\in T} X(t) \geq u\}$ can be approximated by $\mathbb{E}\{\varphi(A_u)\}$ such that the error term is exponentially smaller than $\mathbb{E}\{\varphi(A_u)\}$. This work is an extension of Taylor, Takemura and Adler (2005) where the mean Euler characteristic approximation for excursion probability of smooth Gaussian field with constant variance was first obtained. (Received September 04, 2012)

1084-60-323 **Patrick W Starvaggi*** (pstarvaggi@gmail.com). *On the SPRT for exponential random variables.* Preliminary report.

The sequential probability ratio test (SPRT) has been proven optimal in the case of the sequential analysis of two simple statistical hypotheses. The SPRT can be regarded as a two sided stopping rule for a real valued discrete time stochastic process. This presentation will outline the calculation of the moment generating function for this stopping rule in the case of testing exponential data. (Received September 04, 2012)

1084-60-343 **Peter M Kotelenez*** (pxk4@case.edu), Department of Mathemtics, case Western Reserve University, University Circle, Cleveland, OH 44106. *Metrics on Signed Measures and the Hahn-Jordan Decomposition for Signed Measure Valued Stochastic Partial Differential Equations.*

Let N point particles be distributed over $\mathbb{R}^d$, $d \in \mathbb{N}$. The position of the i-th particle at time t will be denoted $r(t, q^i)$ where q^i is the position at $t = 0$. $m_i \in \mathbb{R} \setminus \{0\}$ is the "weight" of the i-th particle. Let δ_r be the point measure concentrated in r and $\mathcal{X}_N(0) := \sum_{i=1}^N m_i \delta_{q^i}$ the initial mass distribution of the N point particles. The empirical mass distribution (also called the "empirical process") at time t is then given by

$$\mathcal{X}_N(t) := \sum_{i=1}^N m_i \delta_{r(t,q^i)} = \int \delta_{r(t,q)} \mathcal{X}_N(0, dq),$$

i.e., by the $N-$particle flow. The motion of the positions of the point particles is described by a stochastic ordinary differential equation (SODE). The resulting empirical process is the solution of a stochastic partial differential equation (SPDE) which, by a continuum limit, can be extended to an SPDE in smooth positive measures Introducing a quotient space type metric on the signed measures, we prove the preservation of the Hahn-Jordan decomposition.

This talk is based on joint work with B. Seadler. (Received September 04, 2012)

1084-60-347 **Song Yao*** (songyao@pitt.edu), Pittsburgh, PA 15260, and **Erhan Bayraktar** (erhan@umich.edu), Ann Arbor, MI 48109. *On Zero-Sum Stochastic Differential Games.*

We generalize the results on zero-sum stochastic differential games to the case when the controls are unbounded. We do this by proving a dynamic programming principle using a covering argument instead of relying on a discrete approximation. We define our pay-off through a backward stochastic differential equation. The value functions turn out to be the viscosity solutions of some fully non-linear PDEs. (Received September 04, 2012)

1084-60-354 **Aurel Iulian Stan*** (stan.7@osu.edu), 1465 Mount Vernon Avenue, Marion, OH 43302. *Some inequalities for norms of Poissonian Wick Products (joint work with Alberto Lanconelli, University of Bari, Italy).* Preliminary report.

We introduce first the Poissonian Wick Product using the Charlier orthogonal polynomials generated by the Poisson probability measure. We find then a pointwise formula for the Poissonian Wick Product. We use the pontwise formula to find inequalities about the L^1 and L^∞ norms of the Poissonian Wick Product. We use the formula, in terms of the Charlier polynomials, to find inequalities about the L^2 norms of the Poissonian Wick Product. Finally, we use Stein Analytic Interpolation Theorem to find inequalities about the L^p norms of the Poissonian Wick Product, for p other than 1, 2, and ∞. (Received September 04, 2012)

1084-60-368 **Lu Chen*** (chenlu81@hotmail.com), **Omar De la Cruz Cabrera** and **Oana Mocioalca**. *Diffusion Models with Pre-specified Dirichlet Marginal Distribution.* Preliminary report.

We describe a stochastic process in continuous time with a pre-specified Dirichlet distribution as invariant distribution; therefore, with the appropriate initial state, we obtain that all the marginal distributions are the specified Dirichlet.

The process is obtained as the solution of a stochastic differential equation driven by a standard Brownian motion; we describe the corresponding drift and autocorrelation function. Also, more complicated models will be discussed, such as a model driven by Fractional Brownian Motion. We also discuss applications such as modeling compositional data. (Received September 05, 2012)

62 ► Statistics

1084-62-200 **Katharine Turner*** (kate@math.uchicago.edu), kate@math.uchicago.edu, and **Yuriy Mileyko**, **Sayan Mukherjee** and **John Harer**. *Fréchet means for distributions of persistence diagrams (Part 1).*

One of the central objects in Applied Topology is the persistence diagram. We consider the space of such diagrams as a metric space under a version of the Wasserstein distance and show it is a non-negatively curved Alexandrov space. We define the Fréchet mean for a probability distribution. This talk endeavors to give an intuition about geodesics in the space of persistence diagrams and what the Fréchet mean of finitely many persistence diagrams is. (Received September 01, 2012)

1084-62-238 **Katharine Turner**, **Yuriy Milyeko** and **Sayan Mukherjee*** (sayan@stat.duke.edu), Durham, NC 27708, and **John Harer**. *Fréchet means for distributions of persistence diagrams (Part 2).* Preliminary report.

We state requirements for a topological summary to be used in inference. For the case of the persistence diagram we develop these requirements and give examples of how this summary can be used in inference. Examples include law of large numbers, hypothesis testing, and classification/regression. (Received September 03, 2012)

65 ► Numerical analysis

1084-65-5 **Nguyen S Hoang*** (nhoang@math.ou.edu), Department of Mathematics, The University of Oklahoma, Norman, OK 73019. *A version of the Dynamical Systems Method for solving equations with linear operators.*

A version of the Dynamical Systems Method (DSM) for solving equations with linear operators is studied in this paper. A discrepancy principle for choosing stopping time is proposed and justified. Based on the DSM an iterative scheme with a stopping rule of Discrepancy Principle type is proposed and justified. Convergence of Newton's method for finding the stopping time from the proposed Discrepancy Principle is proved. It is proved that the proposed methods have order optimal error estimates under some source conditions. Efficiency of the new method for deconvolution is illustrated. (Received June 04, 2012)

68 ► Computer science

1084-68-74 **Tamal K Dey*** (dey.8@osu.edu), Dept. of CSE, The Ohio State U., 2015 Neil Avenue, Columbus, OH 43210, and **Fengtao Fan** and **Yusu Wang**. *Computing Topological Persistence for Simplicial Maps.*

Algorithms for persistent homology and zigzag persistent homology are well studied for homology modules where homomorphisms are induced by inclusion maps. However, the same is not true for homomorphisms induced by other continuous maps such as simplicial ones. In this work, we propose a practical algorithm for computing persistence and zigzag persistence with homology under $\mathbb{Z}_2$ coefficients for a sequence of general simplicial maps. We leverage the fact that every simplicial map can be simulated by inclusion maps. This helps to convert a (possibly zigzag) filtration induced by simplicial maps into another zigzag filtration induced by only inclusion maps sharing the same persistence diagram. Furthermore, the persistent homology for a non-zigzag filtration connected by simplicial maps can be directly computed using the recently introduced concept of annotations. The maintenance of a consistent annotation implies the maintenance of a consistent cohomology basis, which by duality, also implies a consistent homology basis. With this new tool, we also provide an alternative way to approximate the persistence diagram of a filtration of Rips complexes where vertex collapses are used to tame the blow-up in size. (Received August 22, 2012)

1084-68-105 **Tamal Dey** and **Yusu Wang***, yusu@cse.ohio-state.edu. *Reeb graphs: Approximation and Persistence.*

Given a continuous function $f : X \to R$ on a topological space X, its level set $f^{-1}(a)$ changes continuously as the real value a changes. Consequently, the connected components in the level sets appear, disappear, split and merge. The Reeb graph of f summarizes this information into a graph structure. Previous work on Reeb graph mainly focused on its efficient computation. In this talk, we will study two different aspects of the Reeb graph which can facilitate its broader applications in shape and data analysis.

The first one is the approximation of the Reeb graph of a function on a smooth compact manifold M without boundary. The approximation is computed from a set of points P sampled from M. The second aspect concerns the definition and computation of the persistent Reeb graph homology for a sequence of Reeb graphs defined on a filtered space.

This is joint work with T. K. Dey. (Received August 26, 2012)

1084-68-132 **Feodor F. Dragan*** (dragan@cs.kent.edu), Department of Computer Science, Kent State University, Kent, OH 44242, and **Muad Abu-Ata**. *Collective Additive Tree Spanners of Bounded Tree-Breadth Graphs with Generalizations and Consequences.*

We study collective additive tree spanners for families of graphs enjoying special Robertson-Seymour's tree-decompositions, and demonstrate interesting consequences of obtained results. It is known that if a graph G has a multiplicative tree t-spanner, then G admits a Robertson-Seymour's tree-decomposition with bags of radius at most $\lceil t/2 \rceil$ in G. We use this to demonstrate that there is a polynomial time algorithm that, given an n-vertex graph G admitting a multiplicative tree t-spanner, constructs a system of at most $\log_2 n$ collective additive tree $O(t \log n)$-spanners of G. That is, with a slight increase in the number of trees and in the stretch, one can "turn" a multiplicative tree spanner into a small set of collective additive tree spanners. We extend this result by showing that, for every fixed k, there is a polynomial time algorithm that, given an n-vertex graph G admitting a multiplicative t-spanner with tree-width $k-1$, constructs a system of at most $k(1+\log_2 n)$ collective additive tree $O(t \log n)$-spanners of G. (Received August 28, 2012)

70 ► Mechanics of particles and systems

1084-70-217 **Miroslav Kramar***, miroslav@math.rutgers.edu, and **Konstantin Mischaikow**, **Lou Kondic** and **Arnaud Goullet**. *Application of topology to granular materials.* Preliminary report.

The state of granular media can be represented by a persistence diagram. This representation provides an interesting insight into the physical properties of the granular media as demonstrated on a system undergoing compression. Time evolution of the system can be seen as a curve in the space of persistence diagrams. Different notions of distance in this space provide a useful tool for understanding the dynamic. In particular the compressed systems (viewed as a discrete dynamical system) exhibit a few different regimes where dynamics changes from fast to slow. Dependence of the system on its previous state is strongly affected by the sampling rate. We conclude

the talk by addressing the problem of determining the 'appropriate' sampling rate. (Received September 02, 2012)

90 ► Operations research, mathematical programming

1084-90-358 **Kai-Siong Leow*** (kleow@math.kent.edu), Copley, OH 44321. *Pricing of Swing Options: A Monte Carlo Simulation Approach.*

We study the problem of pricing swing call, swing put and swing strangle options where the option holder has multiple rights to exercise her options to trade a variable amount of an underlying commodity with a party over a specified time period. The problem is formulated as a stochastic optimal control model in discrete time and numerically solved by an approximate dynamic programming algorithm. (Received September 04, 2012)

94 ► Information and communication, circuits

1084-94-346 **Hai Q Dinh*** (hdinh@kent.edu), Department of Mathematical Sciences, Kent State University, 4314 Mahoning Avenue, Warren, OH 44483. *Skew cyclic codes and some generalizations.*

Using generator polynomials in non-commutative skew polynomial rings, the class of cylic codes is generalized to the class of skew cyclic codes. Given an automorphism θ of a finite field $\mathbb{F}$, a skew θ-cyclic code C of length n is a linear code with the property that

$$(c_0, c_1, \ldots, c_{n-1}) \in C \quad \Rightarrow \quad (\theta(c_{n-1}), \theta(c_0), \ldots, \theta(c_{n-2})) \in C.$$

In this talk, we overview many properties that skew cyclic codes share with cyclic codes. Several generalizations of skew cyclic codes, such as skew constacyclic codes, are discussed. (Received September 04, 2012)

97 ► Mathematics education

1084-97-95 **Edward D. Laughbaum*** (elaughba@math.ohio-state.edu), 231 West 18th Avenue, Columbus, OH 43210. *Connections from Brain Science to Teaching Connections.*

Teaching to the way the brain understands mathematics and to the way it stores and recalls in the long term will be the primary focus of this session. Current teaching practice often forces the brain to use working memory as the structure for memory formation and recall. But "working memory" is fragile and requires constant review to maintain the integrity of the content. The presenter will provide a lesson on core brain function that applies to teaching algebra for understanding and long-term memory with recall. In addition to the neuroscience, the presenter will share sample algebra lessons that implement the neuroscience. (Received August 25, 2012)

1084-97-186 **Timothy C Boester*** (timothy.boester@wright.edu). *An example of using action research to help a pre-service teacher study pedagogical content knowledge.*

Pre-service secondary teachers tend to not see many connections between the mathematics courses required to earn a baccalaureate degree and the comparably brief investigation of the pedagogical knowledge necessary for high school math instruction. One way to alleviate this problem is to view college education not as a place where students only acquire factual information, but instead as a place where students can practice learning. By providing experiences for undergraduates as researchers, both in mathematics and in mathematics education, teachers will have the tools to continue learning once they reach their own classrooms. This alleviates the intractable problem of covering all the content and all the pedagogy necessary for teaching. This paper presents the details of an action research project, focused on promoting understanding of absolute value in an eighth grade classroom, conducted with a pre-service high school math teacher. The experiences of carefully considering how students might conceptualize absolute value, reading the relevant literature, designing an activity, implementing it in a classroom, and reflecting upon the results model the desired future behavior of a secondary teacher. (Received August 31, 2012)

1084-97-325 **G. Arthur Mihram***, P.O. Box No. 1188, Princeton, NJ 08542-1188, and **Danielle Mihram**, Univ Sthrn Calif: LVL-113, 650 W. 35th St: #113, Los Angeles, CA 90089-2571. *Teaching Mathematics: If it's Not Science, Is it Neither Necessary Nor Sufficient for Science?* Preliminary report.

Mathematics teachers may, in Quinn's conclusion [NOTICES, AMS 59: 31, 2012], heighten students' interest: Mathematics is not science since Science [being that human activity devoted to providing the very explanation

for (i.e., the truth about) any particular naturally occurring phenomenon] requires a 'model' for any explanation. But, such a model achieves the status of a [scientific] truth only if the explanation concurs with observations subsequently made outside the text (the model) in Nature. Yet, mathematics, in seeking truth, looks internally (the search for logical error within the 'model'). So, is mathematics either necessary or sufficient for Science? First, mathematics is not necessary: e.g., Darwin's ORIGIN OF THE SPECIES contains no mathematical structure, only its logical rectitude vis-à-vis Nature. Secondly, our mathematics is not sufficient for Science: Euclid's ELEMENTS makes no reference to real-world phenomena, yet reaches irrefutable 'truths' (conclusions: 'QED'), but only regarding mental constructs [points, lines, circles, triangles. e.g.]. Teachers of mathematics can appreciate, indeed, that mathematics [itself an art (language), not a science] serves ideally to discipline the mind, a quite welcome attribute for any student ready to enter citizenship. (Received September 04, 2012)

1084-97-328 **Antonio R Quesada*** (aquesada@uakron.edu), The University of Akron, Math Department, College of Arts and Sciences Room 220, Akron, OH 44325-4002, and **Laurie A Dunlap** (dunlapl@uakron.edu), The University of Akron, Math Department, College of Arts and Sciences Room 220, Akron, OH 44325-4002. *The Preparation of Secondary Mathematics Teachers on nontraditional content, tools, and methods, which are facilitated by Technology- Part I.*

For the last five years we have studied how hand-held graphing technology (HHGT) is being integrated in the teaching and learning of mathematics. Our ultimate goal was to determine if we are we preparing our pre-service secondary teachers to properly use the capabilities that hand-held graphing technology (HHGT) provides. To answer this question, we first established criteria on how the integration of HHGT, without CAS, expands the depth and breadth of the study of mathematics at the secondary level. We have looked at concepts, mathematical tools, representations, and problem solving approaches being taught beyond traditional secondary mathematics, as well as to didactical methods that technology facilitates and research favors. Then we have gathered data from pre-calculus textbooks, pre-service secondary teachers, and secondary teachers. In this presentation we will share some of the results obtained from the analysis of the textbooks, and from a test based on the established criteria administered to teachers and to pre-service teachers. (Received September 04, 2012)

1084-97-333 **Laurie A. Dunlap*** (dunlapl@uakron.edu), The University of Akron, Mathematics Department, College of Arts and Sciences, Akron, OH 44325-4002, and **Antonio R. Quesada** (aquesada@uakron.edu), The University of Akron, Mathematics Department, College of Arts and Sciences, Akron, OH 44325-4002. *The Preparation of Secondary Mathematics Teachers on Nontraditional Content, Tools, and Methods, Which are Facilitated by Technology- Part II.*

For the last five years we have studied how hand-held graphing technology (HHGT) is being integrated in the teaching and learning of mathematics. Our ultimate goal was to determine if we are we preparing our pre-service secondary teachers to properly use the capabilities that hand-held graphing technology (HHGT) provides. To answer this question, we first established criteria on how the integration of HHGT, without CAS, expands the depth and breadth of the study of mathematics at the secondary level. We have looked at concepts, mathematical tools, representations, and problem solving approaches being taught beyond traditional secondary mathematics, as well as to didactical methods that technology facilitates and research favors. In this presentation we will share some of the results obtained from a workshop for inservice secondary mathematics teachers over discrete mathematics and statistics. This will include a discussion of the content, test results, and pedagogical strategies. (Received September 04, 2012)

1084-97-334 **Leigh V Slauson***, lslauson@capital.edu. *The Statistical Education of Future Teachers.*

My current research focuses on how context provides meaning for data analysis and the evaluation of evidence but may be distracting to students. I currently work with three other statistics educators from across the country to research how undergraduate statistics students come to understand the process of random sampling and whether their preconceived opinions about a particular topic influences their ability to assess the quality of a study's methodology. I am interested in all issues related to statistics education and I host the monthly activity webinar series for CAUSE (Consortium for the Advancement of Undergraduate Statistics Education), an NSF grant that is headquartered at The Ohio State University. Given the increasing emphasis on data analysis at the secondary level, I believe it is very important to discuss the current state statistical education of secondary teachers and how it can be improved. (Received September 04, 2012)

1084-97-341 **Ali Hajjafar*** (hajjafar@uakron.edu), The University of Akron, Department of Mathematics, Akron, OH 44325-4002, and **Laurie A. Dunlap** (dunlapl@uakron.edu), The University of Akron, Department of Mathematics, Akron, OH 44325-4002. *How to Develop Students' Skills for Solving Problems Using Multiple Strategies.*

Described in this talk will be a strategy for how secondary teachers can lead their students to become capable of self-direction and original thinking. The strategy involves solving a problem with an easily found answer using multiple methods. These methods are increasingly complex and require students to recall a variety of mathematical content. The process, of solving a single problem from multiple perspectives, solidifies the students' knowledge while building connections between ideas. It allows them to integrate and synthesize what they have learned (Received September 04, 2012)

1084-97-360 **Lynne M Pachnowski*** (lmp@uakron.edu), Zook 133, College of Education, University of Akron, Akron, OH 44325-4205, and **Linda Marie Saliga** (saliga@uakron.edu), CAS 268, Dept of Theoretical and Applied Math, University of Akron, Akron, OH 44325-4002. *A Gap Analysis of the Mathematics of a Math Teacher Preparation Program With Regard to the Common Core Standards For Mathematics.* Preliminary report.

With the transition from K-12 math curriculum based on the NCTM (National Council of Teachers of Math) to the Common Core Standards for Mathematics, teacher preparation programs also need to evaluate their programs and revise to meet the new expectations. The Ohio Department of Education, for example, has provided documents to assist school districts in completing a gap analysis of their mathematics curriculum. The districts are documenting what portions of their curriculum meet the new standards, what addresses the standards, and what remains to be addressed and, therefore, added. This study completes a gap analysis on the mathematics within the K-3, 4-9, and 7-12 mathematics teacher preparation programs within a large, Midwestern, metropolitan university with a large teacher preparation program. The program has exhibited success in preparing mathematics teachers as evidenced by a fairly high percentage of passing Praxis II Math Content exam scores. The study results will demonstrate those areas that can be deemphasized, those that should remain, and those needing increased emphasis. The results will provide a process and a template for other institutions to use to perform the same analysis and, therefore, to make necessary revisions. (Received September 04, 2012)

1084-97-364 **Joanne E Goodell*** (j.goodell@csuohio.edu), 2121 Euclid Ave, Department of Teacher Education, JH 346, Cleveland, OH 44115. *CSUTeach: Implementing project-based instruction in a mathematics teacher education program.*

In 2005, concern over the declining position of the United States in technological enterprises prompted the National Academy of Sciences and National Academy of Engineering to commission the report "Rising Above the Gathering Storm" (Committee on Prospering in the Global Economy of the 21st Century: An Agenda for American Science and Technology, 2007). In it, a teacher preparation program at the University of Texas at Austin (UTeach) was cited as one that should be scaled up across the nation to address the declining population of high school mathematics and science teachers. Cleveland State University is now one of more than 30 universities replicating this program. There are a number of interdependent features of this program that are not necessarily new or unique, but when brought together in one package, create a powerful model that has proven very successful. In 2010, we accepted our first students, in May 2012, 14 students completed the program, and all had secured teaching jobs by the end of July. In this session, I will describe the components of the new CSUTeach mathematics teacher preparation program including the focus on project-based instruction, outline some of the issues we have faced during the past two years, and look to future developments. (Received September 04, 2012)

00 ► General

1085-00-16 **William Yslas Velez*** (velez@math.arizona.edu), Department of Mathematics, University of Arizona, Tucson, AZ 85721. *Mathematics majors in the workforce, a panel discussion.* Preliminary report.

Mathematics faculty view the undergraduate mathematics major as leading to two career paths, pre-college mathematics teachers and graduate school in the mathematical sciences. The majority of students who graduate with undergraduate degrees in mathematics do not pursue either of these two options.

Our department is seeing many of our undergraduates adding mathematics as another major and using this extra major to be more competitive to get into graduate programs other than the mathematical sciences. However, the majority of mathematics majors join the workforce.

In this panel, three students who earned undergraduate degrees in mathematics and immediately joined the workforce will discuss their career paths and the role that mathematics has played in their current positions. The three panelists are:

Rene Bernal, Applied Software Engineer, Honeywell Chris Elofson, Senior Software Engineer, Raytheon Carolyn Lanser, Senior Member of the Technical Staff, Rincon Research (Received July 05, 2012)

1085-00-230 **Enrique Acosta*** (eacosta@math.arizona.edu), Department of Mathematics, The University of Arizona, 617 N. Santa Rita Ave., Tucson, AZ 85721-0089. *Leading order asymptotics of a multi-matrix partition function for colored triangulations.*

I will present a partition function that counts colored triangulations that is given as a multi-matrix integral, and will then discuss results aimed at justifying a method that has been proposed by Physicists to study its first order asymptotics. (Received September 10, 2012)

1085-00-245 **Phillip Walker*** (phillip.walker@asu.edu) and **Wenbo Tang**. *Finite-time statistics of scalar diffusion in Lagrangian coherent structures.*

When investigating chaotic mixing in nonlinear aperiodic dynamic systems, the domain can be frame-independently partitioned into different regions identified by Lagrangian coherent structures (LCS). We consider stochastic scalar dispersion associated with LCS and find that the statistics of various moments exhibit strong coherence in separate flow partitions. The probability density of dispersion approach self-similar profiles with anomalous exponents at intermediate time scales. Such coherence in statistics indicate that the Lagrangian topology highlight variability of diffusion. In this talk we explore such correlation between Lagrangian topology, as identified by LCS, and effective mixing. (Received September 10, 2012)

1085-00-257 **Vladimir Zakharov*** (zakharov@math.arizona.edu), Department of Mathematics, University of Arizona, Tucson, AZ 85721-0089. *Turbulence in Integrable Systems.*

Nonlinear wave systems integrable by Inverse Scattering Method (ISM) could demonstrate a complex behavior that demands the statistical description. The theory of this description composes a new chapter in the theory of wave turbulence - Turbulence in Integrable Systems. All systems integrable by ISM are separated in two classes: strongly and weakly integrable. Systems of both classes have infinite array of motion constants but only for strongly integrable systems this array is complete. As a result, the scattering is trivial in these systems. It means that all the collision terms in kinetic equations of arbitrary high order are identically zero. The examples of strongly integrable systems are: KdV, NLSE and KP-2 equations. In strongly integrable systems one can choose as initial data a statistically homogenous random field with a given pair correlation function such that this function is invariant in time. The spatial spectrum of an equilibrium state can be chosen in an arbitrary way. In weakly integrable systems (KP-1, three-wave system, etc) the kinetic equations are non-trivial. (Received September 11, 2012)

1085-00-269 **Alessandra Graf*** (ag668@nau.edu). *A New Graceful Labeling for Pendant Graphs.*

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. Previous research has shown that all coronas $C_n \odot K_1$ have a graceful

labeling of the second kind. In this presentation we will show that all coronas $C_n \odot K_1$ with $n \equiv 3, 4 \pmod 8$ also have a graceful labeling of the first kind. (Received September 11, 2012)

05 ► Combinatorics

1085-05-7 **Matt Katz*** (katz@math.psu.edu). *Quotient Diagrams of Partitions.*
In 1986, J. Propp proposed the problem of counting the number of quotient diagrams of partitions. A quotient diagram is the result of "modding out" a partition by an $a \times b$ lattice. In this talk, we will see outlines of proofs of the 2×2 and 2×4 cases in which we get generating functions for each. (Received April 08, 2012)

1085-05-92 **Eric M Rains** and **Monica Vazirani*** (vazirani@math.ucdavis.edu), One Shields Ave, Davis, CA 95616. *Deformations of permutation representations of Coxeter groups.*
One can deform a Coxeter group W to its corresponding Hecke algebra $H(W)$ and a standard parabolic subgroup W_I to a corresponding subalgebra $H(W_I)$. However, this is not the case for every subgroup U, even if U is conjugate parabolic. Sometimes one can still deform the associated permutation representation on cosets W/U.

Our motivating example is the action of the symmetric group on fixed-point-free involutions by conjugation.

In this talk, I'll define a larger class of "quasiparabolic" subgroups and more generally quasiparabolic W-sets, and show that they admit a flat deformation over $Z[q]$ to a representation of $H(W)$. They also share other nice properties with W/W_I such as a shellable Bruhat order. (Received September 02, 2012)

1085-05-127 **Ae Ja Yee*** (yee@math.psu.edu) and **Atul Dixit**. *Generalized higher order spt-functions.*
Two fundamental statistics in the theory of partitions are Dyson's rank and the Andrews-Garvan crank, which provide combinatorial proofs of partition congruences modulo 5,7, and 11. Recently, Andrews introduced spt(n), the number of appearances of the smallest parts in all partitions of n, and he showed how spt(n) is related to the second rank and crank moments. Since the introduction, the spt-function has attracted a lot of attention due to its rich properties, in particular its connections to the partition function p(n), ranks, and cranks. I will give a new generalization of the spt(n) in my talk. This is joint work with Atul Dixit from Tulane University. (Received September 05, 2012)

1085-05-218 **Jonathan Novak*** (jnovak@math.mit.edu), Massachusetts Institute of Technology, 77 Massachusetts Avenue, Building 2, Office 339, Cambridge, MA 02139. *Monotone Hurwitz numbers and the HCIZ integral.*
An old conjecture due to A. Matytsin claims that, under suitable hypotheses, the logarithm of the Harish-Chandra-Itzykson-Zuber integral admits a large N asymptotic expansion in powers of N^{-2}. Although this is analogous to the well-known topological expansion of Hermitian matrix models, Matytsin did not conjecture any interpretation, topological or otherwise, for the coefficients in his conjectural expansion.

I will present joint work with Ian Goulden and Mathieu Guay-Paquet in which we show that, if Matytsin's conjecture holds, the coefficients must be generating functions for a desymmetrized version of Okounkov's double Hurwitz numbers, which we call "monotone double Hurwitz numbers." The combinatorial analysis of these monotone Hurwitz numbers allows us to prove that the HCIZ free energy converges uniformly on compact subsets of a complex domain for a large class of potentials of an "arithmetic" nature. This proves a conjecture of Collins, Guionnet and Maurel-Segala for this class of potentials. (Received September 10, 2012)

1085-05-232 **Patrick Thomas Waters***, pwaters@math.arizona.edu. *Enumerating g-Maps with Odd Valences.* Preliminary report.
g-Maps are classes of graphs embedded on compact Riemann surfaces. The Wick calculus relates generating functions for g-map counts to asymptotics of recurrence coefficients for orthogonal polynomials. Much is known about generating functions for g-maps with even valences. The "odd valence case" is significantly more complicated, but exposes new and interesting aspects of the g-map enumeration problem. (Received September 10, 2012)

11 ► Number theory

1085-11-1 **Ken Ono*** (ono@mathcs.emory.edu), Dept Math and Computer Science, Emory University, Atlanta, GA 30322. *Adding and Counting.*

One sees that

$$4 = 3 + 1 = 2 + 2 = 2 + 1 + 1 = 1 + 1 + 1 + 1,$$

and so we say that $p(4) = 5$. This is the "stuff" of partitions. Underlying this simple task of adding and counting, one finds some difficult (but simple to state) problems. Some of these problems have fascinated many leading mathematicians: Euler, Ramanujan, Hardy, Rademacher, Dyson, to name a few. And as is typical in number theory, some of these fundamental questions have remained open. In 2010, the speaker, with the support of the American Institute for Mathematics and the National Science Foundation, assembled a team of researchers to attack some of these problems. The speaker will describe their findings: new theories which solve some of the famous old questions. (Received February 13, 2012)

1085-11-30 **Frank H Thorne*** (thorne@math.sc.edu) and **Jeremy Rouse**. *Large degree Galois representations of fields of small discriminant.*

Suppose that L/K is a Galois extension where the root discriminant of L is small. Then we prove that $Gal(L/K)$ must have irreducible complex representations whose degree is bounded below. In particular, this implies that $Gal(L/K)$ cannot be "too abelian".

We give two proofs of our result. The first proof uses character theory to reduce the problem to studying an abelian subextension L/K. The second involves the analytic properties of the Artin L-functions associated to $Gal(L/K)$; the result is quantitatively better, bur it is conditional on GRH and the Artin Conjecture. In both cases the idea is to prove that there cannot be too many representations of low degree and conductor.

This is joint work with Jeremy Rouse. (Received August 03, 2012)

1085-11-35 **Alexander Berkovich*** (alexb@ufl.edu), Department of Mathematics, University of Florida, 358 Little Hall, Gainesville, FL 3626111. *Rogers-Ramanujan functions, binary quadratic forms and eta-quotients.*

In a handwritten manuscript published with his lost notebook, Ramanujan stated without proofs forty identities for the Rogers-Ramanujan functions. We observe that the function that appears in Ramanujan's identities can be obtained from a Hecke action on a certain family of eta products. We establish further Hecke-type relations for these functions involving binary quadratic forms. Our observations enable us to find new identities for the Rogers–Ramanujan functions and to find new identities involving binary quadratic forms. This talk is based on a joint work with H. Yesilyurt. (Received August 10, 2012)

1085-11-54 **Robert Osburn*** (robert.osburn@ucd.ie), School of Mathematical Sciences, University College Dublin, Belfield, Dublin, 4, Ireland, and **Jeremy Lovejoy** (lovejoy@liafa.jussieu.fr), LIAFA, Universite Denis Diderot-Paris 7, Case 7014, 75205 Paris Cedex 13, 75205 Paris, France. *The mixed mock modularity of q-hypergeometric series.*

Mixed mock modular forms are functions which lie in the tensor space of mock modular forms and modular forms. They have recently appeared in a wide variety of areas such as characters arising from affine Lie superalgebras, the quantum theory of black holes and q-series and partitions. We discuss various ways to produce individual examples and infinite families of q-hypergeometric series which are mixed mock modular forms. This is joint work with Jeremy Lovejoy (Paris 7). (Received August 24, 2012)

1085-11-58 **Amy Feaver***, amy.feaver@colorado.edu, and **M.J. Bertin**, **J. Fuselier**, **M. Lalin** and **M. Manes**. *Mahler measure of some singular $K3$-surfaces.*

We study the Mahler measure of the three-variable Laurent polynomial $x+1/x+y+1/y+z+1/z-k$ where k is a parameter. The zeros of this polynomial define (after desingularization) a family of $K3$-surfaces. In favorable cases, the $K3$-surface has Picard number 20, and the Mahler measure is related to its L-function. This was first studied by Marie-José Bertin who proved formulas in the cases of $k = 0, 2$ and 10. In this work we prove new formulas, corresponding to $k = 3, 6$ and 18. (Received August 27, 2012)

1085-11-79 **Krishnaswami Alladi*** (alladik@ufl.edu), Department of Mathematics, 358 Little Hall, University of Florida, Gainesville, FL 32611. *Partitions with non-repeating odd parts and q-hypergeometric identities.*

By considering 2-modular Ferrers graphs and a Durfee square analysis of them, we obtain a two parameter key identity in which the product term is the generating function of partitions where the odd parts do not repeat.

This two variable identity leads to a unified treatment of several important q-hypergeometric identities and also provides extensions of some of them. These include the famous Lebesgue identity and its special case the Gauss triangular series theorem, and the Rogers-Fine identity. The approach also yields an analytic representation for a variation of the deep theorem of Göllnitz in the form of a three parameter identity. (Received August 31, 2012)

1085-11-91 **Pavel Guerzhoy***, Department of Mathematics, University of Hawaii at Manoa, 2565 McCarthy Mall, Honolulu, HI 96822. *On the second solution of KZ differential equation.*

KZ equation was first written down by Kaneko and Zagier in the connection with supersingular j-invariants. The equation was further investigated in a series of papers by Kaneko and Koike. That is a second order linear differential equation, and it is expected to have two solution. In many cases, both solutions were explicitly written down, and they are modular forms. However, in the original case, only one modular solution is known, and it was conjectured by Kaneko and Koike that the second solution is not modular. We show that it is indeed the case: the second solution is not a modular form, but a mixed mock modular form. (Received September 02, 2012)

1085-11-93 **Larry Rolen*** (larryrolen@gmail.com) and **Michael Griffin**. *Integrality Properties of Symmetric Functions in Singular Moduli.*

In his work *On Singular Moduli*, Zagier defined the class polynomial; a polynomial whose roots are traces of special values of modular functions (singular moduli). He then then showed that the trace of these values can be expressed in terms of coefficients of weight 3/2 modular forms. This phenomena was explored further by Duke in Jenkins, who demonstrated conditions under which the traces of singular moduli for non-holomorphic modular functions must be integral. In this paper, we consider other symmetric functions in the singular moduli for non-holomorphic modular functions, and give conditions under which these symmetric functions are integral, or for which they are rational with an explicit bound on the denominator. (Received September 02, 2012)

1085-11-106 **Sharon Anne Garthwaite*** (sag028@bucknell.edu) and **Paul Jenkins** (jenkins@math.byu.edu). *Zeros of weakly holomorphic modular forms of level 2 and 3.* Preliminary report.

F. K. C. Rankin and Swinnerton-Dyer elegantly proved that the zeros of the classical Eisenstein series lie on the unit circle, a boundary of the fundamental domain. We prove similar results for a family of low-level weakly holomorphic forms. Let $M_k^\sharp(N)$ be the space of modular forms for $\Gamma_0(N)$ that are holomorphic at all cusps except possibly at ∞. We study a canonical basis for $M_k^\sharp(2)$ and $M_k^\sharp(3)$ and prove that almost all modular forms in this basis have the property that the majority of their zeros in a fundamental domain lie on a lower boundary arc of this domain. (Received September 04, 2012)

1085-11-110 **Riad Masri*** (masri@math.tamu.edu) and **Sheng-Chi Liu**. *Equidistribution of quadratic roots in the level aspect.*

We will discuss various equidistribution problems concerning roots of quadratic congruences, with a particular emphasis on the connections between these problems and automorphic forms and L-functions. (Received September 04, 2012)

1085-11-111 **Jennifer A Bryson** (j.bryson@tamu.edu), **Ken Ono** (ono@mathcs.emory.edu), **Sarah C Pitman*** (spitman@emory.edu) and **Robert C Rhoades** (rob.rhoades@gmail.com). *Unimodal sequences and quantum and mock modular forms.*

We show that the *rank* generating function $U(t;q)$ for strongly unimodal sequences lies at the interface of quantum modular forms and mock modular forms. We use $U(-1;q)$ to obtain a quantum modular form which is "dual" to the quantum form Zagier constructed from Kontsevich's "strange" function $F(q)$. As a result we obtain a new representation for a certain generating function for L-values. The series $U(i;q) = U(-i;q)$ is a mock modular form, and we use this fact to obtain new congruences for certain enumerative functions. (Received September 04, 2012)

1085-11-123 **Dinesh S. Thakur*** (thakur@math.arizona.edu). *Multizeta and motives in the global function field setting.*

We will describe progress and open questions regarding the multizeta values defined in the global function field setting by the author and their relations with Anderson's t-motives. (Received September 05, 2012)

1085-11-154 **Yingkun Li*** (yingkun@math.ucla.edu), UCLA Mathematics Department Box 951555, Los Angeles, CA 90095-1555, and **William Duke** (wdduke@math.ucla.edu), UCLA Mathematics Department Box 951555, Los Angeles, CA 90095-1555. *Mock-modular forms of weight one.*

Given a weight one newform of level N and nebentypus χ, the Deligne-Serre Theorem attaches an irreducible, 2-dimensional complex representation of $\mathrm{Gal}(K/\mathbb{Q})$ for some number field K. Depending on the image of the associated projective representation, the newform is either called dihedral or exotic. In this talk, we will look at weight one mock-modular forms with dihedral newforms of prime level as shadows. Their Fourier coefficients are logarithms of absolute values of algebraic numbers in K. We will explain their relationships to Stark's conjecture and differences of singular moduli. Finally, we will make a conjecture about the factorizations of these algebraic numbers and provide numerical evidence in an exotic case. (Received September 07, 2012)

1085-11-179 **Guy Henniart** and **Luis Lomelí*** (lomeli@math.ou.edu), Department of Mathematics, University of Oklahoma, Norman, 73019-3103. *Characterization of γ-factors: the Asai case.*

Let E be a separable quadratic extension of a locally compact field F of positive characteristic. Asai γ-factors are defined for smooth irreducible representations π of $\mathrm{GL}_n(E)$. If σ is the Weil-Deligne representation of $\mathcal{W}_E$ corresponding to π under the local Langlands correspondence, we show that the Asai γ-factor is the same as the Deligne-Langlands γ-factor of the Weil-Deligne representation of $\mathcal{W}_F$ obtained from σ under tensor induction. This is achieved by proving that Asai γ-factors are characterized by their local properties together with their role in global functional equations for L-functions. As an immediate application, we establish the stability property of γ-factors under twists by highly ramified characters. (Received September 10, 2012)

1085-11-181 **Scott D. Ahlgren** and **Byungchan Kim*** (bkim4@seoultech.ac.kr), School of Liberal Arts, SeoulTech, 172 Gongreung 2dong, Seoul, 139-743, South Korea. *Congruences of mock modular forms.*

Ranaujan's striking partition congruences have motivated much research on congruences of weakly holomorphic forms. In this talk, I will discuss congruence properties for the coefficients of mock modular forms. (Received September 10, 2012)

1085-11-194 **Bruce C. Berndt*** (berndt@illinois.edu), Department of Mathematics, University of Illinois, Urbana, IL 61801. *A survey of Bessel function identities connected with the classical circle and divisor problems.*

Let $r_2(n)$ denote the number of representations of n as a sum of two squares, and let $d(n)$ denote the number of positive divisors of n. The classical circle and divisor problems ask for the correct orders of magnitude of the error terms in the asymptotic formulas for the summatory functions of $r_2(n)$ and $d(n)$, respectively. These error terms can be represented by infinite series of Bessel functions. We begin our survey with the classical results of Voronoi, Ramanujan, and Hardy, in particular. Secondly, we focus on two associated Bessel series expansions found in Ramanujan's lost notebook and the efforts of Sun Kim, Alexandru Zaharescu, and the speaker to prove them. We conclude our survey with some new Bessel series expansions by the same three authors that are motivated by the two expansions from the lost notebook. (Received September 10, 2012)

1085-11-203 **Tim Huber*** (hubertj@utpa.edu), University of Texas - Pan American, and **Matthew Levine** (malevine@broncs.utpa.edu), University of Texas - Pan American. *Elliptic interpolation of Hecke Eisenstein Series.*

Recently, S. Cooper has given a novel construction of Hecke Eisenstein series for the congruence subgroup $\Gamma_0(n)$ by making use of the Jacobi triple product identity and properties of Gauss sums. In this lecture, an alternative formulation is given for Hecke Eisenstein series in terms of derivatives of the Weierstrass $\wp$-function. The Eisenstein series associated with primitive Dirichlet character χ are expressed as linear combinations of Weierstrass values with coefficients which are Gauss sums. These identities may be used to deduce interesting new information about Eisenstein series and associated theta functions. In particular, such constructions lead to a new differential system for quintic theta functions and to the realization of symmetry in corresponding parameterizations for quintic Eisenstein series. (Received September 10, 2012)

1085-11-204 **Dermot McCarthy*** (mccarthy@math.tamu.edu). *Hypergeometric Functions over Finite Fields and Siegel Modular Forms.*

Hypergeometric functions over finite fields were introduced by Greene in the 1980's as analogues of the classical hypergeometric function. His motivation was to 'bring some order' to the area of character sums and their evaluations by appealing to the rich theory of the classical function, and, in particular, its transformation properties. Since then, these finite field hypergeometric functions have also exhibited interesting properties in

other areas. In particular, special values of these functions have been related to the Fourier coefficients of certain elliptic modular forms. Relationships with Siegel modular forms of higher degree are also expected. We will outline recent work on proving an example of such a connection, whereby special values of the hypergeometric function are related to eigenvalues associated to a Siegel eigenform of degree 2.

This is joint work with Matt Papanikolas. (Received September 10, 2012)

1085-11-205 **Atul Dixit** and **Arindam Roy*** (roy22@illinois.edu), 1409 West green street, Urbana, IL 61801, and **Alexandru Zaharescu**. *Ramanujan-Hardy-Littlewood-Riesz phenomena for Hecke forms.*

We generalize a Ramanujan-Hardy-Littlewood result to primitive Hecke forms, which interestingly exhibits faster convergence than in the initial case of the Riemann zeta function. We also provide a criterion in the spirit of Riesz for the Riemann Hypothesis for the associated L-functions. (Received September 10, 2012)

1085-11-208 **Jeremy Rouse***, Wake Forest University, Department of Mathematics, Winston-Salem, NC 27109. *Spaces of modular forms generated by eta quotients.* Preliminary report.

Many modular forms may be easily expressed as an eta quotient, an expression of the form

$$\prod_{\delta|N} \eta(\delta z)^{r_\delta}$$

where the $r_\delta \in \mathbb{Z}$. Ono raised the problem of classifying spaces of modular forms generated by eta quotients, and we will provide some answers to two different interpretations of this problem. (Received September 10, 2012)

1085-11-210 **Amanda Folsom** (amanda.folsom@yale.edu) and **Susie Kimport*** (susie.kimport@yale.edu). *Mock Modular Forms and Singular Combinatorial Series.*

In this talk, we study general infinite families of combinatorial q-series pertaining to k-marked Durfee symbols, in which we allow additional singularities. We show that these singular combinatorial families are essentially mixed mock and quasimock modular forms, and provide their explicit non-holomorphic completions. As a special case of our work, we consider $k = 3$, and provide an asymptotic expansion for the associated partition rank statistic, solving a special case of a problem of Andrews. (Received September 10, 2012)

1085-11-212 **Robert J Lemke Oliver*** (rlemkeo@emory.edu), Dept. of Mathematics and Computer Science, Emory University, 400 Dowman Dr, Atlanta, GA 30322. *New results in the pretentious analytic number theory of Granville and Soundararajan.*

Granville and Soundararajan have recently introduced the notion of pretentiousness in the study of multiplicative functions of modulus bounded by 1, essentially the idea that two functions which are similar in a precise sense should exhibit similar behavior. It turns out, somewhat surprisingly, that this does not directly extend to detecting power cancellation - there are multiplicative functions which exhibit as much cancellation as possible in their partial sums that, modified slightly, give rise to functions which exhibit almost as little as possible. We develop new notions of pretentiousness under which power cancellation can be detected, one of which applies to a much broader class of multiplicative functions. We also consider a question of extreme cancellation for multiplicative functions defined via the arithmetic of number fields. This work is joint with Junehyuk Jung. (Received September 10, 2012)

1085-11-214 **Michael John Griffin***, Dept. of Mathematics and Computer Sci., W401, Emory University, Atlanta, GA 30322, and **Andreas Malmendier** and **Ken Ono**. *SU(2)-Donaldson invariants of the complex projective plane.*

There are two families of Donaldson invariants for the complex projective plane, corresponding to the SU(2)-gauge theory and the SO(3)-gauge theory with non-trivial Stiefel-Whitney class. In 1997 Moore and Witten conjectured that the regularized u-plane integral on $\mathbb{C}\mathrm{P}^2$ gives the generating functions for these Donaldson invariants. In earlier work, the second two authors proved the conjecture for the SO(3)-gauge theory. Here we complete the proof of the conjecture by confirming the claim for the SU(2)-gauge theory. (Received September 10, 2012)

1085-11-217 **J. Brandt Kronholm*** (kronholm@juniata.edu), 1700 Moore Street, Department of Mathematics, Huntingdon, PA 16652. *Towards a Complete Characterization of New Ramanujan Congruence Properties of the Restricted Partition Function $p(n, m)$.*

In this presentation we will discuss an intriguing extension of a previous result regarding $p(n, m)$, the restricted partition function that enumerates the number of partitions of n into exactly m parts. This extension reveals further symmetries of the generating function for $p(n, m)$ and may allow us to gain a better understanding of

these Ramanujan-like congruences. Moreover, this extension agrees with the Hardy-Ramanujan-Rademacher formula for $p(n)$ when n is negative, namely, $p(n) = 0$. (Received September 10, 2012)

1085-11-220 **Matthew Boylan*** (boylan@math.sc.edu), 1523 Greene St., Columbia, SC 29208, and **John Webb**. *The partition function modulo prime powers.*

Recently, Folsom, Kent, and Ono discovered surprising general arithmetic properties of values of $p(n)$, the ordinary partition function, modulo prime powers. More precisely, let $\ell > 3$ be prime, and let m be a positive integer. Their work implies systematic linear relations modulo ℓ^m among values of $p(n)$ in certain arithmetic progressions modulo ℓ^b for all odd $b > b(\ell, m)$, a constant depending on ℓ and m.

In this talk, we prove a refined upper bound on $b(\ell, m)$. Our bound is sharp in all computed cases. Abstractly, $b(\ell, m)$ measures the stabilization rate of a certain sequence of modules of modular forms with coefficients reduced modulo ℓ^m. To define these modules, Folsom, Kent, and Ono introduce a new operator, $D(\ell)$. We obtain our bound by carefully studying how $D(\ell)$ effects filtrations of the relevant modular forms.

This is joint work with John Webb. (Received September 10, 2012)

1085-11-237 **Paul Jenkins*** (jenkins@math.byu.edu). *Zeros and congruences of weakly holomorphic modular forms.* Preliminary report.

We discuss recent results on the locations of the zeros of certain weakly holomorphic modular forms of small level and congruences for their Fourier coefficients. (Received September 10, 2012)

1085-11-258 **Jeremy Rouse** and **John J Webb*** (webbjj@wfu.edu), Department of Mathematics, Wake Forest University, P.O. Box 7388, Winston-Salem, NC 27109. *Improved bounds for p-core partitions.* Preliminary report.

Let p be a prime greater than or equal to 5. We say a partition of n is p-core if none of the hook-lengths in the corresponding Ferrers-Young diagram for the partition is divisible by p. By showing that the generating function for p-core partitions is very nearly an Eisenstein series, we obtain optimal lower bounds for the number of p-core partitions. This builds upon previous work of Granville and Ono, Kim and Rouse, as well as others. (Received September 11, 2012)

1085-11-262 **Marie Jameson*** (mjames7@emory.edu), Department of Mathematics, 400 Dowman Drive, Atlanta, GA 30322. *A Problem of Zagier on Quadratic Polynomials and Continued Fractions.*

For any non-square $1 < D \equiv 0, 1 \pmod 4$, Zagier defined

$$A_D(x) := \sum_{\substack{\mathrm{disc}(Q)=D \\ Q(\infty)<0<Q(x)}} Q(x)$$

and proved that $A_D(x)$ is a constant function. For rational x, it turns out that this sum is finite. Here we address the infinitude of the number of quadratic polynomials for nonrational x, and more importantly address some problems posed by Zagier related to characterizing the polynomials which arise in terms of the continued fraction expansion of x. In addition, we study the divisibility of the constant functions $A_D(x)$ as D varies, by using the Cohen-Eisenstein series and various Hecke-type operators. (Received September 11, 2012)

1085-11-268 **Karl Mahlburg*** (mahlburg@math.lsu.edu) and **Kathrin Bringmann**. *Asymptotic equality of positive crank and rank moments.*

Andrews, Chan, and Kim recently introduced a modified definition of crank and rank moments for integer partitions that allows the study of all moments, following Atkin and Garvan's earlier study of even moments. The main result of this talk states that while the two families of moment functions are asymptotically equal, the crank moments are always asymptotically larger than the rank moments.

The generating functions include expressions involving false theta functions, and the proofs require the Circle Method along with other analytic techniques, such as Mittag-Leffler theory and Mellin transforms. (Received September 11, 2012)

1085-11-280 **J. Bober**, **A. Deines**, **S. Pancratz**, **A. Shnidman**, **C. Vincent*** (cvincent@stanford.edu) and **W. Stein**. *Tables of elliptic curves over $\mathbb{Q}(\sqrt{5})$.* Preliminary report.

Large tables of elliptic curves have proven invaluable to formulate and test conjectures. Perhaps the most well-known of these is Cremona's table, which lists all elliptic curves over $\mathbb{Q}$ of conductor up to 270,000, along with extensive data about each curve. In particular, this table confirms that 234,446 is the smallest conductor of a rank 4 curve over $\mathbb{Q}$. Under both the Birch and Swinnerton-Dyer conjecture and the modularity conjecture for $\mathbb{Q}(\sqrt{5})$,

we are currently in the process of enumerating all elliptic curves over $\mathbb{Q}(\sqrt{5})$ up to norm conductor $1,209,079$, and of computing the rank of each of these curves. In addition to providing more data for mathematicians to use, this will allow us to find the first curves of rank 3 and 4. In this talk we will talk about the results and the various algorithms that we use to accomplish this. (Received September 11, 2012)

13 ► Commutative rings and algebras

1085-13-9 **Olgur Celikbas*** (celikbaso@missouri.edu), 323 Mathematical Sciences Bldg, University of Missouri, Columbia, MO 65211, and **Srikanth Iyengar**, **Greg Piepmeyer** and **Roger Wiegand**. *Torsion in the tensor product of modules.* Preliminary report.

Let R be a commutative local complete intersection ring of codimension c and let M and N be finitely generated R-modules, where $c \geq 2$. I will discuss certain depth conditions on the modules M, N and $M \otimes_R N$ under which the vanishing of $\eta_c^R(M,N)$ ($\eta(-,-)$ is a pairing initially defined by H. Dao) forces the vanishing of $\operatorname{Tor}_{>0}^R(M,N)$ and implies the depth equality $\operatorname{depth}(M) + \operatorname{depth}(N) = \operatorname{depth}(R) + \operatorname{depth}(M \otimes_R N)$. The talk is based on a joint work with Srikanth Iyengar, Greg Piepmeyer and Roger Wiegand. (Received September 01, 2012)

1085-13-41 **Malik Sami Bataineh*** (msbataineh@just.edu.jo), J.U.S.T, P.O.Box 3030, Irbid, 22110, Jordan, and **Ala' Khazaa'leh** (a.kazaaleh@yahoo.com), J.U.S.T, P.O.Box 3030, Irbid, 22110, Jordan. *Graded Primary Submodules Over Multiplication Modules.*

Let G be an abelian group with identity e, R be a $G-$graded commutative ring and M a graded $R-$module where all modules are unital. Various generalizations of graded prime ideals and graded submodules have been studied. For example, a proper graded ideal I is a graded weakly (resp; almost) prime ideal if $0 \neq ab \in I$ (resp; $ab \in I - I^2$) then $a \in I$ or $b \in I$. Also a proper graded submodule N of M is graded primary submodule if $rm \in N$, then either $m \in N$ or $r \in \sqrt{(N : M)}$.

Throughout this work, we define that a proper graded submodule is a graded weakly (resp; almost) primary submodule if $0 \neq rm \in N$ (resp; $rm \in N - (N : M)N$), then either $m \in N$ or $r \in \sqrt{(N : M)}$. We give some properties and characterizations of graded weakly (resp; almost) primary submodules. We show that graded weakly primary submodules enjoy analogs of many of the properties of prime submodules and primary submodules. (Received August 16, 2012)

1085-13-53 **Nicholas Baeth*** (baeth@ucmo.edu) and **Alfred Geroldinger**. *Arithmetic of Direct-sum Decompositions of Modules.* Preliminary report.

Let $(R, \mathfrak{m})$ be a one-dimensional Noetherian local ring with $\mathfrak{m}$-adic completion $\hat{R}$. Given the structure of how the minimal primes of $\hat{R}$ lie over the minimal primes of R together with the ranks of indecomposable torsion-free $\hat{R}$-modules, one can completely describe the monoid of torsion-free R-modules with operation given my direct sum. In this talk we consider the arithmetic of the submonoid constructed using only certain indecomposable $\hat{R}$-modules with "trivial" ranks, and thus exhibit non-uniqueness in direct-sum decompositions of torsion-free R-modules. (Received August 23, 2012)

1085-13-55 **Kuei-Nuan Lin***, Department of Mathematics, University of California, Riverside, Riverside, CA 92521, and **Claudia Polini**, Department of Mathematics, University of Notre Dame, Notre Dame, IN 46556. *Rees Algebras of Truncations of Complete Intersections.* Preliminary report.

This is joint work with C. Polini. The Rees algebra of an ideal provides an algebraic realization for the classical notion of blowing up a variety along a subvariety, which is a fundamental operation in algebraic geometry and commutative algebra. Understanding the defining ideal of a Rees algebra is difficult in general. In collaboration with Polini, we treat the case of ideals in a polynomial ring defined by forms of the same degree that arise as truncations of regular sequences of length two. We think of these defining ideals as divisors of normal domains. In this context, we study the Cohen-Macaulayness and regularity of Rees algebras as well. (Received August 25, 2012)

1085-13-56 **Hal Schenck**, **Alexandra Seceleanu** and **Javid Validashti*** (jvalidas@illinois.edu). *Bigraded Minimal Free Resolutions of Tensor Product Surfaces.*

In a recent study of the bigraded commutative algebra of a three dimensional base point free subspace $W \subseteq H^0(\mathcal{O}_{\mathbb{P}^1 \times \mathbb{P}^1}(2,1))$, Cox, Dickenstein and Schenck have shown that there are two numerical types of possible bigraded minimal free resolution of the ideal I_W. In a joint work with H. Schenck and A. Seceleanu we consider four dimensional base point free subspaces W and we prove that there are exactly six numerical types of possible bigraded minimal free resolution of I_W. (Received September 04, 2012)

1085-13-57 **Sean Sather-Wagstaff*** (sean.sather-wagstaff@ndsu.edu). *Weakly Spherical DG Modules over Koszul Complexes.* Preliminary report.

Let $(R, \mathfrak{m}, k)$ be a commutative local noetherian ring, and let $K = K^R(\mathbf{x})$ be the Koszul complex over R on the sequence $\mathbf{x} = x_1, \dots, x_n \in \mathfrak{m}$. Given an integer $n \geq 1$, a homologically finite DG K-module X is *weakly n-spherical* if

$$\operatorname{Ext}^i_R(X, X) \cong \begin{cases} 0 & \text{for } i \neq 0, n \\ k & \text{for } i = 0, n. \end{cases}$$

(This definition is motivated by the notion of "spherical objects" from derived algebraic geometry.) For instance, if R is a DVR, then k is a weakly 1-spherical DG R-module. We prove (a) this is essentially the only way to construct weakly n-spherical DG R-modules, and (b) for $n \neq 2$, this is essentially the only way to construct weakly n-spherical DG K-modules. (Received August 26, 2012)

1085-13-61 **Susan Elaine Morey*** (morey@txstate.edu), Department of Mathematics, 601 University Dr., San Marcos, TX 78666. *Depths and Cohen-Macaulay Properties of Square-free Monomial Ideals.* Preliminary report.

A square-free monomial ideal I in a polynomial ring R can be associated with a graphical or combinatorial representation. We will use such representations to give lower bounds on the depths of certain classes of square-free monomial ideals (or their powers), and to identify a class of ideals for which R/I is always Cohen-Macaulay. In this talk, we focus on edge ideals and path ideals of graphs. The results presented will involve joint work with multiple authors, including a group of undergraduate research students. (Received August 28, 2012)

1085-13-97 **Jason McCullough*** (jmccullough@msri.org). *Syzygy Bounds on the Regularity of Ideals.*

Let R be a standard graded polynomial ring over a field K and let I be a homogeneous ideal of R. We investigate what can be said about $reg(R/I)$ in terms of some of the maximal degree syzygies. We write $t_i = regTor_i(R/I, K)$. Examples of Mayr and Meyer show that t_2 can be double exponential in terms of t_1. We show that $reg(R/I)$ is bounded by a polynomial in $t_1 ... t_h$, where h is at least $1/2 dim R$. We also discuss similar results and the possibility of stronger bounds. (Received September 03, 2012)

1085-13-104 **Petter Andreas Bergh**, **David A. Jorgensen*** (djorgens@uta.edu) and **Steffen Oppermann**. *Triangulated defect categories.* Preliminary report.

We define for any additive category P a fully faithful triangle functor from the homotopy category of "totally acyclic" complexes in P to an analogue of the stable derived category, namely the Verdier quotient of the homotopy category of the right bounded "eventually acyclic" complexes in P modulo the homotopy category of bounded complexes in P. Given a triangulated subcategory C of the homotopy category of totally acyclic complexes in P, we consider the thick closure of the image of C, and call the corresponding Verdier quotient the defect category of C. One application is where P is the category of finitely generated projective modules over a commutative local ring, or a finite dimensional algebra. In this case the defect category of the full homotopy category of totally acyclic complexes in P we call the Gorenstein defect category; it's triviality is a triangulated categorical reformulation of the Auslander-Bridger characterization of Gorenstein rings as those rings over which all finitely generated modules have finite Gorenstein dimension. The dimension (in the sense of Rouquier) of the defect category thus gives a measure of how close the ring is to being Gorenstein. (Received September 03, 2012)

1085-13-148 **Bruce Olberding*** (olberdin@nmsu.edu), Department of Mathematical Sciences, New Mexico State University, Las Cruces, NM 88011, and **Francesca Tartarone** (tfrance@mat.uniroma3.it), Dipartimento di Matematica, Universitá degli Studi "Roma Tre", Largo San Leonardo Murialdo 1, 00146 Roma, Italy. *Irreducible components of the closed fiber of a modification of a two-dimensional regular local ring.*

Let D be a two-dimensional regular local ring, and let $\phi : X \to \operatorname{Spec}(D)$ be a modification (i.e., proper birational morphism) of schemes, where X is normal. By Zariski's Connectedness Theorem, the closed fiber of ϕ is connected, so that if the fiber is not irreducible, then any irreducible component of the fiber must intersect some other irreducible component of this fiber. We discuss some constraints on where this intersection must occur. This translates into a question regarding when the exceptional prime ideals of a finitely generated birational extension of D are comaximal. Our methods are valuation-theoretic and have application to the problem of classifying the not-necessarily-Noetherian integrally closed rings between D and its quotient field. (Received September 07, 2012)

1085-13-151 **Jared L Painter*** (jpainter@hbu.edu), 7502 Fondren Rd, Lakehouse 118, Houston, TX 77074. *Methods for Classifying the Tor Algebra Structure for Trivariate Monomial Ideals.* Preliminary report.

We will discuss methods that can be used to classify the Tor algebra structure for R/I, where $R = \Bbbk[x, y, z]$ and I is a monomial ideal primary to the homogeneous maximal ideal $\mathfrak{m}$ of R such that $I \subseteq \mathfrak{m}^2$. Our classification is based off of recent work by L. Avramov where he classified the behavior of Bass numbers of embedding codepth 3 commutative local rings. His classification relied on a corresponding classification of their respective Tor algebras, which is comprised of five categories. We will see how we can use a graphical representation of the minimal free resolution of R/I along with some special properties of minimal resolutions for trivariate monomial ideals to classify the Tor algebra structure for R/I. In addition we will give a general classification of the Tor algebra structure for a special type of trivariate monomial ideals and discuss new examples in one of the five categories. (Received September 07, 2012)

1085-13-164 **Hailong Dao***, Department of Mathematics, University of Kansas, Lawrence, KS 66049. *On the existence of non-trivial semi-dualizing modules.*

Let R be a normal Cohen-Macaulay local ring. In this talk I will describe some recent evidence indicating that the existence of non-trivial semi-dualizing modules forces Spec(R) to have "bad" singularities. Some of the results are joint works with O. Celikbas. (Received September 08, 2012)

1085-13-175 **Amanda Croll***, 203 Avery Hall, University of Nebraska-Lincoln, P.O. Box 880130, Lincoln, NE 68505. *Periodic modules over a Gorenstein local ring.* Preliminary report.

This work concerns finitely generated modules over a commutative Gorenstein local ring R. It is proved that the minimal free resolution of such a module M is eventually periodic if, and only if, the class of M is torsion in a certain $\mathbb{Z}[t, t^{-1}]$-module associated to R. This module, which we denote $J_R(t)$, is a quotient of the free $\mathbb{Z}[t, t^{-1}]$-module on the isomorphism classes of finitely generated R-modules by relations reminiscent of those defining the Grothendieck group of R. The main result is a structure theorem for $J_R(t)$ when R is a complete Gorenstein local ring; the link between periodicity and torsion stated above is a corollary. As a consequence, a complete Gorenstein local ring has an eventually periodic module if and only if the module $J_R(t)$ has nontrivial torsion. (Received September 09, 2012)

1085-13-188 **Branden Stone*** (bstone@bard.edu), Bard College, PO Box 5000, Annandale, NY 12504. *Super-Stretched and Graded Countable Cohen-Macaulay Type.*

This work was motivated by a question of Huneke and Leuschke; let R be a complete local Cohen-Macaulay ring of countable Cohen-Macaulay type, and assume that R has an isolated singularity. Is R then necessarily of finite Cohen-Macaulay type? We show that such a ring is super-stretched. We also give a partial result to a the following folklore conjecture: A Gorenstein ring of countable Cohen-Macaulay type is a hypersurface. In particular, we show this conjecture is true in the one dimensional graded case. (Received September 10, 2012)

1085-13-190 **Andrew Kustin**, **Janet Striuli** and **Adela Vraciu*** (vraciu@math.sc.edu). *Exact pairs of homogeneous zero divisors and Hilbert functions.*

Let S be a standard graded Artinian algebra over a field. We identify constraints on the Hilbert function of S which are imposed by the existence of a pair of homogeneous exact zero divisors. The main numerical constraint we find depends only on the sum of the degrees of the homogeneous exact zero divisors in the pair. (Received September 10, 2012)

1085-13-243 **Courtney Gibbons*** (s-cgibbon5@math.unl.edu), Department of Mathematics, University of Nebraska-Lincoln, PO Box 880130, Lincoln, NE 685880130. *Modules over short Gorenstein rings.* Preliminary report.

Given a finitely generated module over a short graded Gorenstein ring, its Betti diagram alone is enough to determines some of its indecomposable direct summands. As with cosyzygies of the residue field, some indecomposable Koszul modules can be recognized from from a small amount of data. (Received September 11, 2012)

1085-13-246 **Janet Striuli*** (jstriuli@fairfield.edu) and **Ian Aberbach**. *Uniform bounds of Artin-Rees type for free resolutions over three dimensional rings.* Preliminary report.

In this talk we will present a result about uniform bounds of Artin-Rees type for infinite free resolutions. Let (R, m) be a local noetherian ring of dimension 3. Given an R-module M, a free resolution (F_i, ∂_i) and an m-primary ideal I, there exists an integer h such that $I^n F_i \cap Im\partial_{i+1} \subseteq I^{n-h} Im\partial_{i+1}$ for all $i \geq 0$ and for all $n \geq h$. (Received September 10, 2012)

14 ► Algebraic geometry

1085-14-38 **Roy Joshua*** (rrjoshua@gmail.com), Department of Mathematics, 231 West 18th Ave, Ohio State University, Columbus, OH 43210, and **Patrick Brosnan**, Department of Mathematics, University of Maryland, College Park, MD 20740. *Comparison of cohomology operations in motivic and etale cohomology.*

In addition to the cohomology operations introduced by Voevodsky in motivic cohomology, there are classical cohomology operations. The former operations are stable with respect to both weight and degree suspension and are defined using a geometric model for the classifying space of finite groups. The latter operations are only stable with respect to degree suspension and arise from the existence of an E_∞-structure on the motivic complexes. The talk, based on joint work with Patrick Brosnan, explores the relationship between these two classes of cohomology operations. (Received August 15, 2012)

1085-14-109 **James D Lewis*** (lewisjd@ualberta.ca), Dept. of Mathematics, University of Alberta, Edmonton, Alberta T6G2G1, Canada. *Hodge Type Conjectures and the Bloch-Kato Theorem.*

We will discuss a version of the Hodge conjecture for higher K-groups, and explore some consequences of an affirmative answer to this conjecture for Abel-Jacobi maps. We further explain the impact of the Bloch-Kato theorem on the cycle class map at the generic point, in the Milnor K-theory case. This talk is based on joint work with Rob de Jeu. (Received September 04, 2012)

1085-14-137 **Matthias Flach*** (flach@caltech.edu), Department of Mathematics, M/C 253-37, Pasadena, CA 91108, and **Yitao Wu** (yitao.wu@gmail.com), Mathematisches Institut, Im Neuenheimer Feld 288, 69120 Heidelberg, Germany. *On the p-adic local invariant cycle theorem.* Preliminary report.

We shall briefly recall the local invariant cycle theorem for regular arithmetic schemes in l-adic cohomology (l different from all residue characteristics) and then formulate a p-adic analogue. We can prove the slope [0,1)-part of this theorem for schemes with semistable reduction. We outline a possible approach to the proof of the slope [0,1)-part in the general regular case using trace maps recently introduced by Berthelot, Esnault and Ruelling. (Received September 06, 2012)

1085-14-171 **Wayne M Raskind*** (raskind@wayne.edu), Department of Mathematics, Wayne State University, Detroit, MI 48202, and **Amnon Besser**. *A Toric Regulator for Curves with Totally Degenerate Reduction over p-adic Fields.* Preliminary report.

Let K be a finite extension of $\mathbb{Q}_p$ and X a smooth projective curve over K with totally degenerate reduction, such as a Mumford curve. We consider $K_2(X)$ and define a regulator from this group to a multiplicative torus of dimension equal to the genus g of X. Assume that $g \geq 2$ and consider the moduli space $\mathcal{M}_g$ of curves of genus g. This is defined over $\mathbb{Q}$. Then X will be called *generic* if the point associated to it in $\mathcal{M}_g$ dominates the generic point of this space. Results of Asakura and Saito show that the image of this regulator is trivial if X is generic in this sense. We study the image of this regulator in various cases and seek to relate generic as defined above to the lack of relations between parameters associated to X such as the multiplicative periods of its Jacobian. (Received September 10, 2012)

1085-14-198 **Matt Kerr*** (matkerr@math.wustl.edu), Department of Mathematics, Campus Box 1146, Washington University in St. Louis, St. Louis, MO 63130. *Indecomposable K_1 and elliptic fibrations on K3 surfaces.*

Given a very general K3 surface with fixed lattice polarization and Picard rank < 20, work of Chen and Lewis implies that there exist sufficient indecomposable algebraic K_1 classes to span the transcendental real $(1,1)$ classes under the real regulator. Since their result was not constructive, one might ask – say, for certain modular families of lattice-polarized K3's studied by Clingher and Doran – for a natural source of cycles. This is provided by the semistable singular fibers in the so-called "alternate" elliptic fibration. The real regulator is indeed nonvanishing on the resulting cycles, but better yet, evaluating it on the family of cycles yields (in the M-polarized case) higher Green's functions. We shall discuss how these results link up with the thesis of A. Mellit and a conjecture of Gross and Zagier. This talk is based on two papers, one of which is joint with X. Chen, C. Doran, and J. Lewis. (Received September 10, 2012)

1085-14-224 **Donu Arapura***, Dept. Mathematics, Purdue University, W. Lafayette, IN 47905.
Varieties with the maximal number of algebraic cycles. Preliminary report.

Given a smooth projective variety over the complex numbers, the dimension of the space of codimension p algebraic cycles is bounded by the Hodge number h^{pp}. We term varieties where this bound is realized Picard maximal. These are interesting for a number of reasons, as I will explain. The main goal of this talk is to discuss some methods for constructing such varieties. A number of examples of Picard maximal surfaces have been known for several decades, but the constructions are usually rather ad hoc. An exception is the class of elliptic modular surfaces due to Shioda. I believe that I have a generalization of this to suitable higher genus fibrations and their fibre products, but the details have not been completely written out, so this will be quite preliminary. (Received September 10, 2012)

1085-14-235 **Kirti Joshi*** (kirti@math.arizona.edu). *Musings on Q(1/4).*

I will talk about motives over finite fields and explain the construction of what should be considered to be a canonical motivic object of weight one half, denoted by Q(1/4) over a finite field. We will also consider some related work in progress. (Received September 10, 2012)

1085-14-254 **Adrian Clingher*** (clinghera@umsl.edu), Department of Mathematics, Express Scripts Hall, One University Blvd., 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 September 11, 2012)

15 ► Linear and multilinear algebra; matrix theory

1085-15-292 **Michael T Zowada*** (mtz6@nau.edu), 901 S. O'Leary St. Apt. 67, Flagstaff, AZ 86001.
An Extension of Yang's Product Construction of Hadamard Matrices.

In 1986, Yang developed an elementary technique for constructing Hadamard-like higher-dimensional arrays from smaller dimensional Hadmard matrices. We will show how Yang's "product construction" actually extends to arrays with complex entries. (Received September 12, 2012)

16 ► Associative rings and algebras

1085-16-94 **Jonathan Brundan*** (brundan@uoregon.edu), Department of Mathematics, University of Oregon, Eugene, OR 97403. *Standard resolutions for quiver Hecke algebras.*

I'll describe some explicit projective resolutions of standard and proper standard modules for quiver Hecke algebras in finite types A, D and E. The resolutions imply various known homological properties. This is a report on joint work with A. Kleshchev. (Received September 02, 2012)

1085-16-98 **Jon F. Carlson**, **Eric M. Friedlander** and **Julia Pevtsova***, julia@math.washington.edu. *Elementary subalgebras of modular Lie algebras.*

Let g be a p-restricted Lie algebra. We call a subalgebra E of g "elementary" of rank r if it is an abelian Lie algebra with trivial p-restriction of dimension r. For a fixed r we consider a projective variety E(r,g) that parameterizes all elementary subalgebras of g of rank r. This variety is a natural generalization of the rank variety introduced by Carlson for elementary abelian p-groups and the support variety for Lie algebras of Friedlander and Parshall.

We'll identify this projective variety in various classical cases. We'll also show how representations of g with special properties lead to constructions of families of vector bundles on E(r,g), thereby extending the study of "modules of constant Jordan type" and their geometric applications to this more general context. (Received September 03, 2012)

1085-16-244 **Lars Winther Christensen*** (lars.w.christensen@ttu.edu) and **Henrik Holm**. *Limits of finite free complexes.* Preliminary report.

In the category of R-modules, every homomorphism from a finitely presented module to a flat module factors through a finitely generated free module, and that property characterized flat modules; this was proved independently by Govorov and Lazard in the 1960s. I will discuss a similar result about complexes of modules and in the process identify which complexes qualify as finitely presented objects in the category of complexes. (Received September 10, 2012)

17 ► Nonassociative rings and algebras

1085-17-128 **Jörg Feldvoss*** (jfeldvoss@southalabama.edu), Department of Mathematics and Statistics, University of South Alabama, Mobile, AL 36688-0002, **Salvatore Siciliano**, Dipartimento di Matematica et Fisica, Università del Salento, I-73100 Lecce, Italy, and **Thomas Weigel**, Dipartimento di Matematica e Applicazioni, Università degli Studi di Milano-Bicocca, I-20125 Milano, Italy. *Restricted Lie algebras with maximal* 0*-PIM.* Preliminary report.

In this talk we derive some results for projective modules over reduced universal enveloping algebras of finite-dimensional restricted Lie algebras. In particular, we determine the projective cover of the trivial irreducible module in the solvable case. As an application we obtain an upper bound for the number of the isomorphism classes of the irreducible representations with a fixed p-character. If time permits, we will also discuss the corresponding situation in the modular representation theory of finite groups. This is joint work with Salvatore Siciliano and Thomas Weigel. (Received September 11, 2012)

19 ► K-theory

1085-19-259 **Rob de Jeu***, Department of Mathematics, De Boelelaan 1081a, 1081 HV Amsterdam, Netherlands. *On the kernel of the tame symbol for K_2 of function fields of curves.* Preliminary report.

Let C be a curve over a field k and $F = k(C)$ its function field. We discuss some subgroups of $K_2(F)$ that contain the kernel of the tame symbol. In computer experiments (performed jointly with Bogdan Banu) some of those appear to admit an explicit description in terms of generators and relations, which are themselves subject to a 5-term relation. (Received September 11, 2012)

20 ► Group theory and generalizations

1085-20-26 **Alexander Hulpke*** (hulpke@math.colostate.edu), Department of Mathematics, Colorado State University, 1874 Campus Delivery, Fort Collins, CO 80523-1874. *Algorithms for representation theoretic calculations in finite matrix groups.* Preliminary report.

Representation theoretic calculations in finite groups typically require knowledge of conjugacy class representatives and their centralizers, as well as the ability to test group elements for conjugacy. Such algorithms have been developed in the last decades for permutation groups and solvable groups. Using the results of the matrix group recognition project (which relies on properties of the natural representation of the group) it is possible to adapt these algorithms for doing calculations in finite matrix groups. (Received July 26, 2012)

1085-20-33 **Takunari Miyazaki** (takunari.miyazaki@trincoll.edu), Computer Science Department, Trinity College, 300 Summit Street, Hartford, CT 06106, and **James B. Wilson*** (jwilson@math.colostate.edu), Department of Mathematics, Colorado State University, 101 Weber Building, Fort Collins, CO 80523. *Centralizers and NP-completeness.* Preliminary report.

Deciding if a nontrivial conjugacy class is the smallest in a group is an NP-complete problem. The surprising implication is that groups with a bounded number of conjugacy class sizes, e.g. Camina groups, are a positive logarithmic proportion of all finite groups. This estimate connects algorithmic complexity theorems of Berman-Hartmanis, Valiant, & Buss et. al. to algebraic enumeration making substantial progress over traditional orbit-stabilizer counting methods. The general technique is discussed as well as related problems. (Received August 09, 2012)

1085-20-39 **Katherine Anne Bird*** (bird10000@gmail.com). *Dade's Ordinary Conjecture (DOC) for the Finite Special Unitary Groups.*

Let G be a finite group and p a prime. The aim of DOC is to count the number of ordinary characters in a block B of p-modular representations and it states:

$$\sum_{C/G} (-1)^{|C|} k(N_G(C), B, d) = 0, \qquad \forall d \geq 0$$

where C is a radical chain of length $|C|$ and $k(N_G(C), B, d)$ is the number of ordinary irreducible characters of height d of the normalizer in G of C in a block that induces, in the Brauer sense, to B.

This has been shown for blocks in the defining characteristic for $\mathrm{GL}_n(q)$ by Olsson and Uno, for $\mathrm{SL}_n(q)$ by Sukizaki, and for $\mathrm{U}_n(q)$ by Ku. We use their methods to prove DOC for $\mathrm{SU}_n(q)$. The main difficulties involved arise because the structure of the unitary groups is more complicated than that of the linear groups. In particular the cancellations in the alternating sum in the unitary case are very different from the cancellations that occur in the general linear case. A key result is that a version of Ku's parametrization of characters survives restriction to the special unitary case. (Received August 15, 2012)

1085-20-40 **Anton Lukyanenko*** (anton@lukyanenko.net) and **Joseph Vandehey**. *Geodesic coding on the complex hyperbolic modular surface.* Preliminary report.

Continued fractions have been used to study the behavior of geodesics in the modular line $H^2/SL(2,Z)$. Is a similar approach available for other quotients of symmetric spaces? We study the notion of a continued fraction on the Heisenberg group, a step-2 nilpotent group that serves as the boundary of complex hyperbolic plane CH^2, and its connection to geodesics in the modular surface $CH^2/SU(2,1;Z[i])$. (Received August 15, 2012)

1085-20-69 **Mark L. Lewis*** (lewis@math.kent.edu), Department of Mathematical Sciences, Kent State University, Kent, OH 44242. *Bounding group orders by large character degrees: A question of Snyder.*

Let G be a nonabelian finite group and let d be an irreducible character degree of G. Then there is a positive integer e so that $|G| = d(d+e)$. Snyder has shown that if $e > 1$, then $|G|$ is bounded by a function of e. This bound has been improved by Isaacs and by Durfee and Jensen. In this talk, we will show for solvable groups that $|G| \leq e^4 - e^3$. Given that there are a number of solvable groups that meet this bound, it is best possible. Our work makes use of results regarding Camina pairs, Gagola characters, and Suzuki 2-groups. (Received August 29, 2012)

1085-20-73 **James Cossey*** (cossey@uakron.edu), Department of Mathematics, University of Akron, Akron, OH 44325-4002. *Brauer graphs of blocks of solvable groups.*

(joint work with Mark Lewis and Marty Isaacs) The Brauer graph is one way to record a large amount of information about a block of a finite group. Much is known about the Brauer graph of a block if the defect group is cyclic. In this work, we examine the question of what occurs if the group G is solvable and the defect group of the block is abelian. Using some "large orbit" results of Dolfi, we see that in this case the Brauer graph has small diameter. We extend this to the situation where the defect group is normal, and end with some open questions. (Received August 30, 2012)

1085-20-74 **Peter A Brooksbank*** (pbrooksb@bucknell.edu), **E A O'Brien** and **J B Wilson**. *Testing isomorphism of finite nilpotent groups.*

A fundamental algorithmic problem in group theory is to test whether or not two groups are isomorphic. This is also a very challenging problem, even for nilpotent groups of class 2. Beyond its intrinsic interest, there is a demand for practical solutions to the problem (for instance, attempts to classify families of p-groups rely on the ability to distinguish members of those families).

I will discuss the isomorphism problem for p-groups of exponent p and class 2. The naïve (until recently, only) approach is to compute subspace orbits under the natural action of $\mathrm{GL}(d,p)$ on the exterior square $(\mathbb{Z}/p)^d \wedge (\mathbb{Z}/p)^d$. The limitations are obvious: orbits very quickly become too large for effective computation.

Recently, a new strategy has emerged to overcome some of the formidable natural obstacles. The central idea is to exploit geometric properties of bilinear maps associated to such groups. Algorithmic tools needed to study such bilinear maps were developed in recent joint work with J.B. Wilson, and may be applied in certain special settings – notably to groups of *corank* 2 – to devise very efficient isomorphism tests. The strategy as a whole is being developed jointly with Wilson and E.A. O'Brien. (Received August 30, 2012)

1085-20-80 **Marcelo Aguiar**, **Nantel Bergeron** and **Nathaniel Thiem*** (thiemn@colorado.edu). *Hopf structures on characters of unipotent groups.*

Finite unipotent groups have notoriously difficult character theories. For example, it remains undecided whether the number of irreducible characters of the maximal unipotent subgroups of the finite general linear group is polynomial in the size of the underlying field. However, by considering infinite families of such groups one obtains a Hopf monoid structure on their characters. This talk will examine some of our favorite examples, and show how they organically give rise to Hopf structures. (Received August 31, 2012)

1085-20-90 **Christopher P. Bendel** and **Daniel K. Nakano*** (nakano@math.uga.edu), Department of Mathematics, University of Georgia, Athens, GA 30602, and **Brian J. Parshall**, **Cornelius Pillen**, **Leonard L. Scott** and **David Stewart**. *Bounding Extensions for Finite Groups and Frobenius Kernels.*

Let G be a simple, simply connected algebraic group defined over an algebraically closed field k of positive characteristic p. Let $\sigma : G \to G$ be a strict endomorphism (i.e., the subgroup $G(\sigma)$ of σ-fixed points is finite). Also, let G_σ be the scheme-theoretic kernel of σ, an infinitesimal subgroup of G. In this talk we show that the degree m cohomology $\mathrm{H}^m(G(\sigma), L)$ of any irreducible $kG(\sigma)$-module L is bounded by a constant depending on the root system Φ of G and the integer m. A similar result holds for the degree m cohomology of G_σ. These bounds are actually established for the degree m extension groups $\mathrm{Ext}^m_{G(\sigma)}(L, L')$ between irreducible $kG(\sigma)$-modules L, L', with again a similar result holding for G_σ. In these Ext^m results, of interest in their own right, the bounds depend also on L, or, more precisely, on length of the p-adic expansion of the highest weight associated to L. All bounds are independent of the characteristic p. (Received September 02, 2012)

1085-20-95 **Jon F. Carlson*** (jfc@math.uga.edu), Department of Mathematics, University of Georgia, Athens, GA 30602. *Computing with matrix and basic algebras.* Preliminary report.

I will discuss computer algorithms aimed at the reduction of finite dimensional algebras, such as group algebras, Hecke algebras or Schur algebras, to their basic algebras. This is for the purpose of extracting information about the representation theory of the algebras. Numerous new programs have been implemented in the computer algebra system MAGMA that compute such things as automorphism groups of algebras and isomorphisms of algebras. Thus we can check that a basic algebra is Kosul and compute ext algebras and cohomology. (Received September 02, 2012)

1085-20-99 **Christopher P Bendel**, **Daniel K Nakano**, **Brian J Parshall** and **Cornelius Pillen*** (pillen@southalabama.edu), Department of Mathematics and Statistics, University of South Alabama, Mobile, AL 36688, and **Leonard L Scott** and **David Stewart**. *Cartan Invariants for Finite Groups of Lie Type, Defining Characteristic.*

Let G be a simple, simply connected algebraic group defined over an algebraically closed field k of positive characteristic p. Let σ be a strict endomorphism on G (i.e., the subgroup $G(\sigma)$ of σ-fixed points is finite). Any strict endomorphism σ of G involves an iteration F^s of the standard Frobenius morphism F on G. We call s the height of σ.

Given a pair of simple $G(\sigma)$-modules L and L', the corresponding Cartan invariant is the multiplicity of L' as a composition factor of the injective hull $U(L)$ of L. In this talk we show that there exists an upper bound $N(\Phi, s)$ for the Cartan invariants of $G(\sigma)$, depending only on the underlying root system Φ of G and the height s of σ. These bounds do not depend on p. We actually prove a stronger result. Namely, that there exists an upper bound $k(\Phi, s)$, not depending on p, for the total number of composition factors of a $U(L)$. Similar results are obtained for G_σ, the scheme-theoretic kernel of σ. (Received September 03, 2012)

1085-20-102 **Bhama Srinivasan**, Department of Math, Stat, and Comp Sci, University of Illiinois at Chicago, 851 South Morgan Street, Chicago, IL 60607, and **C. Ryan Vinroot*** (vinroot@math.wm.edu), Department of Mathematics, College of William and Mary, P. O. Box 8795, Williamsburg, VA 23187. *Jordan decomposition and real-valued characters.* Preliminary report.

Let $\mathbf{G}$ be a connected reductive group defined over a finite field $\mathbb{F}_q$ by Frobenius map F, and let $G = \mathbf{G}^F$. The Jordan decomposition of characters gives a correspondence, with certain invariance properties with respect to Deligne-Lusztig induction, between irreducible characters of G, and pairs (s, ψ), where (s) is a semisimple class in the dual group G^*, and ψ is a unipotent character of $C_{G^*}(s)$, the centralizer of s in G^*. If s is a real element of G^*, suppose $h \in G^*$ such that $hsh^{-1} = s^{-1}$. Then the character ${}^h\psi$, ψ composed with conjugation by h, is also a unipotent character of G^*. We conjecture that the irreducible character of G corresponding to the pair (s, ψ) is real-valued if and only if s is a real element, and ${}^h\psi = \bar{\psi}$, where $hsh^{-1} = s^{-1}$. We give a proof of this in the case that $\mathbf{G}$ has connected center, and the centralizer $C_{G^*}(s)$ is a Levi subgroup of G^*. (Received September 03, 2012)

1085-20-112 **Thomas Michael Keller*** (tk04@txstate.edu), Department of Mathematics, Texas State University, 601 University Drive, San Marcos, TX 78666, and **Yong Yang** (yangy@uwp.edu), Department of Mathematics, University of Wisconsin-Parkside, 900 Wood Road, Kenosha, WI 53141. *Large orbits of finite solvable groups on characters.* Preliminary report.

Let the finite group A act (via automorphisms) on the finite group G. Such an action induces an action of A on the set $\mathrm{Irr}(G)$ in an obvious way (where $\mathrm{Irr}(G)$ denotes the set of complex irreducible characters of G). There

are only very few results on the orbits in this action. One of those results is due to A. Moretó and states that when A is a p-group for a prime p not dividing $|G|$ and G is solvable, then A has a "large" orbit on $\mathrm{Irr}(G)$. We take this result to the next level and establish the existence of a "large" orbit on $\mathrm{Irr}(G)$ in case that A is solvable and G is solvable such that $(|A|, |G|) = 1$. (Received September 04, 2012)

1085-20-142 **Robert Boltje*** (boltje@ucsc.edu). *On p-permuntation equivalences of p-blocks of finite groups.*

A p-permutation module of a group algebra FG in positive characteristic p is a module which becomes a permutation module after restriction to p-subgroups. Equivalently, it is a direct summand of a permutation FG-module. A p-permutation equivalence between two blocks A and B of group algebras FG and FH is an element γ in the Grothendieck group $T(A, B)$ of p-permutation (A, B)-bimodules such that $\gamma \cdot_H \gamma^\circ = [A]$ and $\gamma^\circ \cdot_G \gamma = [B]$, where γ° denotes the dual of γ and $\cdot_H$ is induced by the tensor product over FH. Such equivalences arise for instance from a splendid Rickard equivalence in the context of Broué's conjecture. We study consequences of p-permutation equivalences in the most possible generality. Our main result states that many invariants of the blocks A and B must coincide: Defect groups, inertial quotients, 2-cocycles; and we expect more. Even in the special case that G and H are p-groups one obtains non-trivial results on orthogonal units in the double Burnside ring. Much of the talk is about joint work with my Ph.D. student Philipp Perepelitsky. (Received September 06, 2012)

1085-20-146 **Colva M Roney-Dougal*** (colva@mcs.st-and.ac.uk), Mathematical Institute, North Haugh, St Andrews, Fife KY16 9SS, United Kingdom. *Random generation of finite groups.*

Let G be a finite group. Then by $P_d(G)$ we denote the probability that d independent random elements of G generate the whole group G. It is a famous result due to Liebeck & Shalev, building on work of Kantor & Lubotzky and of Dixon, that if G is simple then $P_2(G) \to 1$ as $|G| \to \infty$.

If G has a normal subgroup N then by $P_{G,N}(d)$ we denote the probability that d randomly chosen elements of G generate G, given that they generate G/N. I'll present some recent joint work with Nina Menezes and Martyn Quick which shows that if G is almost simple with socle S then $P_{G,S}(2) \geq 53/90$, and some applications to random generation of non-simple groups, generation of direct products of simple groups, and the structure and generation of profinite groups. (Received September 07, 2012)

1085-20-149 **Shigeo Koshitani**, **Jürgen Müller** and **Felix Noeske*** (felix.noeske@math.rwth-aachen.de). *Broué's abelian defect group conjecture holds for the double cover of the Higman-Sims sporadic simple group.*

In the representation theory of finite groups, there is a well-known and important conjecture, due to Broué saying that for any prime p, if a p-block A of a finite group G has an abelian defect group P, then A and its Brauer corresponding block B of the normalizer $N_G(P)$ of P in G are derived equivalent. We prove in this paper, that Broué's abelian defect group conjecture, and even Rickard's splendid equivalence conjecture are true for the faithful 3-block A with an elementary abelian defect group P of order 9 of the double cover 2.HS of the Higman-Sims sporadic simple group. It then turns out that both conjectures hold for all primes p and for all p-blocks of 2.HS. (Received September 07, 2012)

1085-20-168 **Amanda A. Schaeffer Fry*** (mandi@math.arizona.edu), University of Arizona, Dept. of Mathematics, Tucson, AZ 85721. *On the Largest Irreducible Representations of the Finite Unitary Groups.*

If G is a finite simple group of Lie type over $\mathbb{F}_q$, then G. Seitz gives us a formula for the largest irreducible complex character degree, $b(G)$, assuming that q is sufficiently large. However, it is still an open question to find such a formula in general. In this talk we will explore this question and some recent results. In particular, I will discuss my bounds for $b(G)$ in the case that G is a finite unitary group. (Received September 09, 2012)

1085-20-174 **Natalie Naehrig*** (naehrig@math.rwth-aachen.de), Templergraben 64, 52062 Aachen, Germany. *On the socle of an endomorphism algebra.*

The underlying background for this talk is Alperin's Weight Conjecture. We let k be an algebraically closed field of positive characteristic p and G be a finite group. Fix a Sylow p-subgroup P and denote the permutation module of the action of G on the right cosets of P in G by k_P^G. In this talk we consider the endomorphism algebra $\mathbf{E}$ of k_P^G. In particular, we focus on the interplay between the socle structure of $\mathbf{E}$ (as right regular module) and the structure of the indecomposable direct summands of k_P^G. (Received September 09, 2012)

1085-20-225 **Gerald Cliff*** (gcliff@ualberta.ca). *Representations of GL(n,R) and Sp(2n,R) where R is a p-adic field or a finite local ring.* Preliminary report.

Suppose that G is a reductive group, such as the general linear group or the symplectic group. Consider the representation space V of a smooth irreducible complex representation of $G(F)$ where F is a p-adic field. Restrict to $G(S)$ where S is the ring of integers of F. This gives rise to a series for V whose factors are irreducible representations of the finite groups $G(S_i)$, for varying i, where S_i is S modulo the i-th power of the maximal ideal of S. We discuss the interconnections between these representations and the original representation . (Received September 10, 2012)

30 ► Functions of a complex variable

1085-30-49 **Ara S Basmajian*** (abasmajian@gc.cuny.edu). *Lengths of closed geodesics on a hyperbolic surface.*

We investigate the relationship, in various contexts, between a closed geodesic with self-intersection number k (for brevity, called a k-geodesic) and its length. For a fixed compact hyperbolic surface, we show that the short k-geodesics grow like the square root of k. On the other hand, if the fixed hyperbolic surface has a cusp and is not the punctured disc, then the short k-geodesics grow logarithmically. The length of a k-geodesic on any hyperbolic surface is known to be bounded from below by a constant that goes to infinity with k. We show that the optimal constants $\{M_k\}$ grow like $\log k$. Moreover, we show that for each natural number k, there exists a hyperbolic surface where the constant M_k is realized as the length of a k-geodesic. This was previously known for $k = 1$, where the figure eight on the thrice punctured sphere is the shortest non-simple closed geodesic. (Received August 22, 2012)

33 ► Special functions

1085-33-3 **Ken McLaughlin*** (mcl@math.arizona.edu), Department of Mathematics, University of Arizona, 617 N. Santa Rita Ave, Tucson, AZ 85719. *Random Matrices, Integrable Systems, Asymptotic Analysis, Combinatorics.* Preliminary report.

If all goes according to plan, most if not all of the topics of the title will be explained and tied together. (Received September 12, 2012)

1085-33-10 **Jonathan M Borwein**, **Armin Straub*** (astraub@tulane.edu), **James Wan** and **Wadim Zudilin**. *An application of modular forms to short random walks.*

We consider random walks in the plane which consist of n steps of fixed length each taken into a uniformly random direction. Our interest lies in the probability distribution of the distance travelled by such a walk. While excellent asymptotic expressions are known for the density functions when n is moderately large, we focus on the arithmetic properties of short random walks.

In the case of three and four steps, the density functions satisfy differential equations of modular origin. This intertwines with the combinatorics of the corresponding even moments and leads to hypergeometric evaluations of the density functions. Much less is known for the density in case of five random steps, but we use the modularity of the four-step case and the Chowla-Selberg formula to deduce its exact behaviour near zero. (Received May 08, 2012)

1085-33-20 **Atul Dixit*** (atuladixit@gmail.com), 312 East Gatehouse Drive, Apt. Q, Metairie, LA 70001. *Analogues of the general theta transformation formula.*

A new class of integrals involving the confluent hypergeometric function ${}_1F_1(a;c;z)$ and the Riemann Ξ-function will be considered. It generalizes a class containing some integrals of S. Ramanujan, G.H. Hardy and W.L. Ferrar and gives as by-products, transformation formulas of the form $F(z,\alpha) = F(iz,\beta)$, where $\alpha\beta = 1$. As particular examples, we will show an extended version of the general theta transformation formula and generalizations of certain formulas of Ferrar and Hardy. A one-variable generalization of a well-known identity of Ramanujan will also be shown. We will conclude with a generalization of a conjecture due to Ramanujan, Hardy and J.E. Littlewood involving infinite series of Möbius function. (Received July 15, 2012)

1085-33-28 **Sergei K. Suslov*** (suslov@math.asu.edu), Arizona State University, School of Mathematical and Statistical Scienc, Tempe, AZ 85287. *An "Airy Gun".*

We present a new solution of the unidimensional linear Schrödinger equation without potential that extend the nonspreading Airy packet introduced by Berry and Balazs. A nonlinear generalization is also discussed. (Received July 29, 2012)

1085-33-48 **Victor H Moll*** (vhm@math.tulane.edu), Department of Mathematics, Tulane University, New Orleans, LA 70118. *An umbral calculus approach to Bernoulli polynomial identities.* Preliminary report.

A variety of nonlinear functionals of Bernoulli polynomials recently proposed by Y. P. Yu are described in terms of a probabilistic approach to umbral calculus. Applications to a variation of Bernoulli numbers given by Zagier are also given. (Received August 21, 2012)

1085-33-71 **Mourad E.H. Ismail** and **Dennis Stanton*** (stanton@math.umn.edu), School of Mathematics, University of Minnesota, 206 Church St SE, Minneapolis, MN 55455. *Orthogonal basic hypergeometric Laurent polynomials.* Preliminary report.

The Askey-Wilson polynomials are orthogonal polynomials in $x = \cos\theta$, which are given as a terminating ${}_4\phi_3$ basic hypergeometric series. The non-symmetric Askey-Wilson polynomials are Laurent polynomials in $z = e^{i\theta}$, which are given as a sum of two terminating ${}_4\phi_3$'s. They satisfy a biorthogonality relation. In this paper we give new orthogonality relations for single ${}_4\phi_3$'s which are Laurent polynomials in z, which imply the non-symmetric Askey-Wilson biorthogonality. (Received August 29, 2012)

1085-33-85 **Mourad E. H. Ismail*** (mourad.eh.ismail@gmail.com), Department of Mathematics, University of Central Florida, Orlando, FL 32816, and **Mizan Rahman** (mrahman109@hotmail.com), Department of mathematics, Carleton University, Ottawa, Ontario K1S5B6, Canada. *Asymptotics of the Landau Constants and Their q-analogue.*

We derive inequalities and a complete asymptotic expansion for the Landau constants as n tends to infinity using the asymptotic sequence n!/(n+k)!. We also introduce a q-analogue of the Landau constants and calculate their large degree asymptotics. In the process we also establish q-analogues of identities due to Ramanujan and Bailey. (Received September 01, 2012)

1085-33-116 **Alexander V Turbiner*** (turbiner@nucleares.unam.mx), Institute de Ciencias Nucleares, UNAM, Apartado Postal 70-543, 04510 Mexico City, DF, Mexico. *BC_2 Lame polynomials.* Preliminary report.

BC_2 elliptic Hamiltonian is two-dimensional Schroedinger operator with double-periodic potential of a special form which does not admit separation of variables. In space of orbits of double-affine BC_2 Weyl group the similarity-transformed Hamiltonian takes the algebraic form of the second order differential operator with polynomial coefficients. This operator has a finite-dimensional invariant subspace in polynomials which is a finite-dimensional representation space of the algebra $gl(3)$. This space is invariant wrt $2D$ projective transformations. BC_2 Lame polynomials are the eigenfunctions of this operator, supposedly, their eigenvalues define edges of the Brillouin zones (bands). (Received September 04, 2012)

1085-33-131 **Roger W. Barnard*** (roger.w.barnard@ttu.edu), Dept. Math & Stat, Texas Tech University, Lubbock, TX 79409. *Applications of Special Functions to Disparate Fields.*

In this talk we discuss several of our recent applications of Special Functions to disparate fields including Number Theory, Abstract Algebra, Probability and Asymptotic Statistics. (Received September 06, 2012)

1085-33-133 **James Mc Laughlin***, West Chester University, West Chester, PA 19383. *Further results on Vanishing Coefficients in Infinite Product Expansions.*

In this talk we extend a result of Andrews and Bressoud on zero coefficients in the expansion of certain infinite q-products. We also consider some of the combinatorial implications. (Received September 06, 2012)

1085-33-242 **Mark W. Coffey*** (mcoffey@mines.edu). *Mellin transforms with only critical zeros.*

Functions possessing zeros only on the critical line Re $s = 1/2$ have been of considerable interest in analytic number theory. We describe representative results of an investigation of Mellin transforms having polynomial factors with zeros only on the critical line, or else on the real line. The results surpass those of [1,2,3]. Joint work with Matthew Lettington (Cardiff University).

References

[1] D. Bump and E. K.-S. Ng, On Riemann's zeta function, Math. Z. **192**, 195-204 (1986).

[2] M. W. Coffey, Special functions and the Mellin transforms of Laguerre and Hermite functions, Analysis **21**, 1001 (2007).

[3] M. W. Coffey, Theta and Riemann xi function representations from harmonic oscillator eigenfunctions, Phys. Lett. A **362**, 352 (2007).

(Received September 10, 2012)

1085-33-252 **Ahmed I. Zayed*** (azayed@depaul.edu), Chicago, IL 60614. *Chromatic Expansions and Orthogonal Polynomials.*

Chromatic derivatives and series expansions have recently been introduced in the class of bandlimited functions as an alternative representation to Taylor series and they have been shown to be more useful in practical applications than Taylor series.

The n-th chromatic derivative $K^n[f](t_0)$ of an analytic function $f(t)$, at t_0 is a linear combination of the ordinary derivatives $f^{(k)}(t_0)$, $0 \leq k \leq n$, where the coefficients of the combination are based on systems of orthogonal polynomials.

In this talk we show that functions in various function spaces and reproducing-kernel Hilbert spaces, including the Bargmann-Segal-Foch space $\mathfrak{F}$, can be represented by chromatic series expansions and as a result some properties of these function spaces can be deduced from those of chromatic series. (Received September 11, 2012)

1085-33-264 **Mathew Rogers*** (mathewrogers@gmail.com), 743 Ave De L'epee, Outremont, QC H2V3V1, Canada. *Mahler measure and statistical mechanics.*

I will discuss several integrals that arise in statistical mechanics, which are related to Mahler measures of multivariable polynomials. I will show that these integrals reduce to ${}_5F_4$ hypergeometric functions. (Received September 11, 2012)

34 ► Ordinary differential equations

1085-34-12 **Yun Kang*** (yun.kang@asu.edu), 6073 S. Backus Mall, Mesa, AZ 85212, and **Carlos Castillo-Chavez**. *A simple epidemiological model with Allee effects and the disease-modified fitness.*

We study the role of an Allee effect on a Susceptible-Infectious (SI) model where both S and I-class can reproduce but with S-class being the best fit. This toy model supports the possibility of multi-stability (hysteresis), saddle node and Hopf bifurcations, and catastrophic events (disease-induced extinction). The analyses provide a full picture of the system under disease-free dynamics including disease-induced extinction and proceed to identify required conditions for disease persistence. We conclude that increases in (i) the maximum birth rate of a species, or (ii) in the relative reproductive ability of infected individuals, or (iii) in the competitive ability of a infected individuals at low density levels, or in (iv) the per-capita death rate (including disease-induced) of infected individuals, can stabilize the system (resulting in disease persistence). We further conclude that increases in (a) the Allee effect threshold, or (b) in disease transmission rates, or in (c) the competitive ability of infected individuals at high density levels, can destabilize the system, possibly leading to the eventual collapse of the population. Our results highlight the significant role that factors like an Allee effect may play on the survival and persistence of animal populations. (Received June 06, 2012)

1085-34-70 **Anthony Michael Bloch*** (abloch@umich.edu), Department of Mathematics, University of Michigan, 530 Church Street, Ann Arbor, MI 48109. *Gradient flows in the normal and Kahler metrics and integrability.*

In this talk I will discuss the geometry of various gradient and Hamiltonian flows with particular application to flows on adjoint orbits of a Lie group and flows on loop groups The role of different metrics will be described. Particular ordinary and partial differential equations will be discussed and their relationship to various integrable systems. I will also analyze hybrid and metriplectic flows that arise when one has both Hamiltonian and gradient components. This is joint work with Phil Morrison and Tudor Ratiu. (Received August 29, 2012)

1085-34-189 **Zoi Rapti*** (zrapti@iilinois.edu). *Multi-breather stability in Klein-Gordon Equations.*

We study the stability of multibreathers in Klein-Gordon equations, using the band structure of the linear Newton operator (Aubry's band theory). We prove Sturm-type criteria for the stability of breathers of given sizes in chains with up to third neighbor interactions. We define a "symmetry" coefficient and use it to study breathers that are not time-symmetric. (Received September 10, 2012)

1085-34-209 **Bijoy K. Ghosh*** (bijoy.ghosh@ttu.edu), Department of Mathematics and Statistics, Texas Tech University, Lubbock, TX 79409-1042, and **Indika Wijayasinghe** (indika.wijayasinghe@ttu.edu), Department of Mathematics and Statistics, Texas Tech University, Lubbock, TX 79409-1042. *A Tale of the Moving Head: How the Head chases the Eye.*

Human head and eye rotate in coordination to rapidly project images of targets from the visual space. Once the image is acquired, the head/eye complex maintains the stability of the image, while the head follows the eye. The individual dynamics of the head and the eye are separately constrained by Donders' and Listing's laws respectively, limiting the possible set of head orientations, once the eye has acquired a target. We parameterize this set as a one parameter curve in the space SO(3) of orientation. We use Riemannian Geometry to write down the dynamics of the eye and the head. Subsequently, we use potential control to derive a trajectory of the head while the eye is controlled to reverse-track the head and maintain a stable image. The main contribution of the talk is to present vestibulo-ocular control using geometric methods on LIST and DOND, the two submanifolds of SO(3). (Received September 10, 2012)

1085-34-253 **Ildar R. Gabitov*** (gabitov@math.arizona.edu), Department of Mathematics, University of Arizona, 617 N. Santa Rita, Tucson, AZ 85721, **Andrei I. Maimistov** (aimaimistov@gmail.com), National Nuclear Research University, MEPhI, Kashirskoe sh. 31, Moscow, 115409, Russia, and **Zhaxylyk Kudyshev** (z.kudyshev@gmail.com), Department of Physics, Al-Farabi Kazakh National University, al-Farabi ave., 71, Almaty, 050038, Kazakhstan. *Second harmonic generation in spatially inhomogeneous metamaterials.*

We investigated theoretically second harmonic generation in metamaterials exhibiting negative index of refraction to a pump field and positive index of refraction to its second harmonic. The process of second harmonic generation in homogeneous metamaterials strongly depends on a phase mismatch and dramatically changes depending on whether the phase mismatch is above or below its critical value. We studied second harmonic generation in inhomogeneous metamaterials when the value of the phase mismatch changes gradually along a sample and crosses its critical value. In this case both regimes of second harmonic generation are present in the same sample. We analyzed transient effects, the distributions of the fundamental and second harmonic fields, conversion efficiency, and the influence of losses. (Received September 11, 2012)

1085-34-276 **Robert Buckingham*** (buckinrt@uc.edu), Department of Mathematical Sciences, University of Cincinnati, PO Box 210025, Cincinnati, OH 45221-0025, and **Peter D. Miller**. *Asymptotics of rational Painleve II functions.*

Rational solutions of the nonhomogenous Painleve II equation have recently been discovered to have applications to fluid vortices, theoretical physics, and nonlinear wave equations. Clarkson and Mansfield observed numerically that the zeros and poles of these rational solutions appear to have a remarkably regular triangular structure. We prove that as the nonhomogeneity parameter tends to infinity the scaled zeros and poles fill out a certain curvilinear triangular region in the complex plane. We also discuss progress on computing the leading-order asymptotic behavior of the rational solutions inside, outside, and at the edge of this root region. This is joint work with Peter Miller. (Received September 11, 2012)

35 ► Partial differential equations

1085-35-4 **Jacob K Sterbenz*** (jsterben@math.ucsd.edu), Jacob Sterbenz, Department of Mathematics, University of California, San Diego (UCSD), La Jolla, CA 92093-0112. *Regularity of energy critical hypberbolic gauge field equations.*

We discuss recent developments in the theory of energy critical geometric wave equations such as the Lorentzian analog of harmonic maps, the so called "wave-maps", and the hyperbolic Yang-Mills equations and related Higgs systems. Considerable progress has been made recently towards understanding the nature of solutions to these equations in the large. After giving a history of the subject we will discuss recent work of several authors, including ongoing projects with Joachim Krieger and Daniel Tataru. (Received September 11, 2012)

1085-35-14 **Lihua Zuo*** (lzuo@math.tamu.edu), lzuo@math.tamu.edu, and **William Rundell** and **Xiang Xu**. *The determination of an unknown boundary condition in a fractional diffusion equation.*

In this paper we consider an inverse boundary problem, in which the unknown boundary function $\frac{\partial u}{\partial \nu} = f(u)$ is to be determined from overposed data in a time-fractional diffusion equation. Based upon the free space

fundamental solution, we derive a representation for the solution f as a nonlinear Volterra integral equation of second kind with a weakly singular kernel. Uniqueness and reconstructability by iteration is an immediate result of a priori assumption on f and applying the fixed point theorem. Numerical examples are presented to illustrate the validity and effectiveness of the proposed method. (Received June 15, 2012)

1085-35-17 **W M Greenlee*** (mgrnle@math.arizona.edu), Department of Mathematics, The University of Arizona, 617 N. Santa Rita Ave., Tucson, AZ 85721-0089, and **Lotfi Hermi** (hermi@math.arizona.edu), Department of Mathematics, The University of Arizona, 617 N. Santa Rita Ave., Tucson, AZ 85721-0089. *Convergence in Multiplicity of the Method of* a posteriori/a priori *Inequalities for Eigenvalues of the Dirichlet Laplacian.* Preliminary report.

The method of *a posteriori/a priori* inequalities is a powerful means of calculating the eigenvalues of self-adjoint partial differential operators. The distinguishing feature of the method is that trial functions need not satisfy any boundary conditions. So trial functions of rather simple form with appropriate smoothness can be employed even over domains with complicated boundaries. We first verify that completeness of the trial functions in the appropriate topology guarantees convergence to the eigenvalue closest to the initial guess. Then, for the Dirichlet Laplacian, we use extension by zero and a modification of the method of truncation to generate convergent lower bounds without the usual requirement that trial functions satisfy boundary conditions. This provides a means of solving the eigenvalue counting problem for the method of *a posteriori/a priori* inequalities when employed for the Dirichlet Laplacian. (Received July 13, 2012)

1085-35-31 **Alla V Balueva*** (abalueva@gsc.edu), Mathematics Department, P.O.Box 1358, Gainesville, GA 30503. *Analyitical solutions for coupled elastisity and diffusion problems on crack growth under gas pressure.*

In pipe-lines, hydrogen absorbed by a metal is typically dissolved in the lattice in the proton form. Some of the protons reach the surface of pre-existing cracks where they form molecular hydrogen, which leads to accumulation of gas hydrogen inside the crack. Hydrogen being accumulated inside the crack cavity creates pressure which eventually leads to the damage of the pipeline. The focus of this study is modeling of how the radius of delamination grows with respect to time. The modeling is based on solving of coupled elasticity and diffusion problem on gas diffusion into the crack cavity and on crack opening under gas pressure. These two problems are coupled through the van der Waals gas state equation, which is valid for high pressures. While the subsequent calculations are somewhat more cumbersome than for the ideal gas case, they are still straightforward that allows obtaining the close-form solution for the crack size, a(t), depending on time. The results reveal some intriguing features worth checking experimentally. In asymptotic approximation, as time is approaching infinity, large pressure driven cracks start growing at the constant speed, besides at exactly the same as the hydrogen driven cracks under the ideal gas conditions. (Received August 07, 2012)

1085-35-36 **Robert Carlson*** (rcarlson@uccs.edu), Department of Mathematics, University of Colorado at Colorado Springs, 1420 Austin Bluffs Parkway, Colorado Springs, CO 80933. *Boundary Value Problems for Infinite Graphs.*

Schrödinger operators are considered on metric graphs with infinitely many edges, but finite diameter. A class of infinite graphs with good function theoretic properties are described. For this class of graphs, Friedrich's extension methods are used to study the well-posedness of boundary value problems with Dirichlet or Neumann conditions on subsets of the boundary of the metric completion of the graph. Existence of a measure-valued Dirichlet-to-Neumann map will be discussed. (Received August 13, 2012)

1085-35-42 **Yulia Karpeshina** and **Roman Shterenberg*** (shterenb@math.uab.edu), Department of Mathematics, University of Alabama at Birmingham, 1300 University Blvd., Birmingham, AL 35294. *Extended States for Polyharmonic Operators with Quasi-periodic Potentials in Dimension Two.*

We consider a polyharmonic operator $H = (-\Delta)^l + V(x)$ in dimension two with $l \geq 2$, l being an integer, and a quasi-periodic potential $V(x)$. We prove that the spectrum of H contains a semiaxis and there is a family of generalized eigenfunctions at every point of this semiaxis with the following properties. First, the eigenfunctions are close to plane waves $e^{i\langle k,x\rangle}$ at the high energy region. Second, the isoenergetic curves in the space of momenta k corresponding to these eigenfunctions have a form of slightly distorted circles with holes (Cantor type structure). A new method of multiscale analysis in the momentum space is developed to prove these results. (Received August 16, 2012)

1085-35-50 **Mikhail D Surnachev*** (peitsche@yandex.ru), Kustanayskaya ul., 5-1-91, Moscow, 115682, Russia. *On stabilization of solutions to nonlinear parabolic equations of the p-Laplace type.*

We study stabilization of solutions to the Cauchy problem

$$u_t = \mathrm{div} A(x,t,\nabla u), \quad x \in \mathbb{R}^n,\ n \geq 2, \quad t > 0, \tag{1}$$

$$u|_{t=0} = f \in L^2_{loc}(\mathbb{R}^n). \tag{2}$$

The flow $A(x,t,\xi)$ is a Carathéodory function satisfying

$$|A(x,t,\xi)| \leq C_0|\xi|^{p-1},\ A(x,t,\xi)\cdot\xi \geq C_1|\xi|^p,$$

where $p > \frac{2n}{n+2}$, and

$$(A(x,t,\xi_2) - A(x,t,\xi_1), \xi_2 - \xi_1) \geq 0.$$

A solution to (1)-(2) is understood in the standard weak sense.

Theorem 1. *Let $p \leq n$. Then for any $f \in L^2(\mathbb{R}^n)$ the energy solution to (1)-(2) converges to zero in $L^2(\mathbb{R}^n)$ as $t \to \infty$.*

Definition. We say that f has the uniform mean $\bar{f}$ if $f(z+\omega x)$ weakly converges to $\bar{f}$ in $L^2_{loc}(\mathbb{R}^n)$ as $\omega \to \infty$ uniformly with respect to $z \in \mathbb{R}^n$.

Theorem 2. *Let u be a bounded solution to (1)-(2). Then u uniformly converges to zero as $t \to \infty$ if and only if f has zero uniform mean.*

Acknowledgements. This work was supported by the Russian Foundation for Basic Research, project nos. 11-01-00989-a and 12-01-00058-a. (Received August 22, 2012)

1085-35-72 **Zhen Qin** and **Roger M. Temam*** (temam@indiana.edu), 831 East Third Street, Rawles Hall, Bloomington, IN 47405. *The Korteweg-de Vries equation on a bounded interval.*

In this lecture we discuss the existence and uniqueness of solutions of the Korteweg-de Vries equation on a bounded finite interval. We also discuss the theoretical and computational treatment of possible incompatibilities between the initial and boundary data. (Received August 29, 2012)

1085-35-81 **Alex Mahalov***, mahalov@asu.edu. *Stochastic 3D Rotating Navier-Stokes Equations: Averaging, Convergence and Regularity.*

Stochastic 3D rotating Navier-Stokes equations are considered. Averaging theorems for the stochastic problems are proven in the case of strong rotation. Regularity results are established by bootstrapping from global regularity of the limit stochastic equations and convergence theorems.

Key words and phrases: Navier-Stokes equations, stochastic partial differential equations, Poincare rotation operator, averaging, convergence, regularity.

REFERENCES F. Flandoli and A. Mahalov (2012), Stochastic 3D rotating Navier-Stokes equations:averaging, convergence and regularity, Archive for Rational Mechanics and Analysis, doi: 10.1007/s00205-012-0507-6, p. 1-43. (Received August 31, 2012)

1085-35-88 **Luan Thach Hoang***, Department of Mathematics and Statistics, Texas Tech University, Box 41042, Lubbock, TX 79409-1042. *The Stokes operator for an interface boundary value problem in two-layer domains.*

We study an interface boundary value problem for Navier-Stokes equations in 3D thin two-layer domains where the top, bottom and interface boundaries are not flat. A Navier-related condition on the common boundary is imposed where the interaction between two fluids is expressed by a linear relation between the normal stress tensor the relative velocity. This interaction and the non-trivial geometry of the boundaries make the problem much more complicated than the single-layer case. We carefully examine the effect of the interaction on the Stokes operator A and estimate the L^2 norm of Au, where u is in the domain of A, with explicit dependence on the thickness of the thin domain, the fluid viscosities and boundary friction coefficients. Under appropriate conditions on the involved parameters, this norm is uniformly equivalent to the H^2 norm of u when the domain becomes very thin. Such a result is important in establishing the global well-posedness of strong solutions to Navier-Stokes equations. (Received September 01, 2012)

1085-35-89 **Guillaume Bal*** (gb2030@columbia.edu). *Hybrid Inverse Problems and partial differential equations.*

Hybrid Inverse Problems are mathematical models for imaging modalities that aim to combine high contrast with high resolution. Several such inverse problems may be modeled as redundant systems of partial differential equations. This talk will present recent results obtained in the field. (Received September 02, 2012)

1085-35-96 **Peter Kuchment*** (kuchment@math.tamu.edu), Mathematics Department, Texas A&M University, College Station, TX 77843-3368, and **Dustin Steinhauer** (dsteinha@math.tamu.edu), Mathematics Department, Texas A&M University, College Station, TX 77843-3368. *Stabilizing inverse problems by internal data.*

We will discuss the question of which kind of internal information, and why could stabilize exponentially unstable inverse problems. Examples are several of the recently being considered coupled physics (or hybrid) imaging modalities. (Received September 02, 2012)

1085-35-103 **Vlad C Vicol***, Department of Mathematics, Princeton University, Fine Hall, Washington Road, Princeton, NJ 08544. *On the continuity of solutions to drift-diffusion equations.*

We consider (linear) drift-diffusion equations with divergence-free drift that belongs to a supercritical space. We prove that starting with smooth initial data solutions may become discontinuous in finite time. This is joint work with L. Silvestre and A. Zlatos. (Received September 03, 2012)

1085-35-107 **Burak Erdogan**, **Nikolaos Tzirakis** and **Vadim Zharnitsky*** (vzh@illinois.edu), 1409 W Green Street, Urbana, IL 61822. *High frequency perturbation of cnoidal waves in KdV.*

The interaction of a cnoidal wave with high frequency radiation of finite energy (L2 norm) is studied in KdV equation with periodic boundary conditions. It is proved that the interaction of low frequency component (cnoidal wave) and high frequency radiation is weak for finite time in the following sense: the radiation approximately satisfies Airy equation. (Received September 04, 2012)

1085-35-117 **Richard Laugesen** and **Bartlomiej Siudeja*** (siudeja@uoregon.edu). *Sharp bounds for spectral functionals.*

We will discuss sharp upper bounds for sums of Laplace eigenvalues on starlike domains. From these we will derive sharp bounds for various spectral functionals, including spectral zeta functions and heat traces. Our method involves volume-preserving transformations, variational formulas and averaging over isometries of the extremizing domain. Surprisingly, we do not need any information about the spectrum of the extremizer. (Received September 05, 2012)

1085-35-122 **Ibrahim Fatkullin***, Dept. of Mathematics, 617 N Santa Rita Ave, Tucson, AZ 85721. *Keller-Segel equations, associated stochastic particle models and numerical methods.*

The Keller-Segel PDEs describe chemotaxis, a phenomenon characterized by the bias of the bacterial motion according to concentration of some chemical. These equations exhibit blow-ups, a mathematical manifestation of the bacteria concentrating at the finest spatial scales. Studying these blow-ups is a challenging problem, both analytically and numerically. I will discuss some associated stochastic particle models and numerical methods which allow us to study this interesting phenomenon. (Received September 05, 2012)

1085-35-124 **Gunther Uhlmann*** (gunther@math.washington.edu) and **Andras Vasy**. *On the local geodesic X-ray transform.*

We discuss some recent results on the geodesic X-ray transform. (Received September 05, 2012)

1085-35-136 **Joceline Lega*** (lega@math.arizona.edu), Department of Mathematics, University of Arizona, 617 N. Santa Rita Avenue, Tucson, AZ 85721. *Dynamics of a thin film equation with disjoining pressure and non-uniform forcing.*

I will consider a model describing the reverse draining of a magnetic film in the presence of disjoining pressure and of a non-uniform body force. By means of a combination of numerical investigations and analytical considerations, I will show that the disjoining pressure appears to regularize the dynamics and select a single steady-state solution for fixed height boundary conditions. I will discuss some of the properties of this solution and explain how it may be found by means of numerically implemented matched asymptotics expansions. I will also present the results of numerical experiments in the limit where the disjoining pressure is sent to zero.

This is joint work with Derek Moulton (University of Oxford, UK). (Received September 06, 2012)

1085-35-162 **Catherine Sulem*** (sulem@math.toronto.edu), Department of Mathematics, University of Toronto, 40 St George Street, Toronto, Ontario M5S2E4, Canada. *Lower bound for the rate of blow-up of singular solutions of the three-dimensional Zakharov system.*

We consider the scalar Zakharov system in $\mathbb{R}^3$. Assuming that the solution blows up in a finite time $t^* < \infty$, we establish a lower bound for the rate of blow-up of the Sobolev norms of the solution. The analysis is a reappraisal of the local wellposedness theory of Ginibre, Tsutsumi and Velo (1997) combined with an argument developed by Cazenave and Weissler (1990) in the context of nonlinear Schrödinger equations.

This is a joint work with Jim Colliander and Magdalena Czubak. (Received September 08, 2012)

1085-35-183 **Bradley E Treeby*** (bradley.treeby@anu.edu.au), Research School of Engineering, The Australian National University, Canberra, ACT 0200, Australia. *Large-scale modeling of nonlinear ultrasound waves in tissue.*

High-intensity focused ultrasound is a noninvasive therapy in which an ultrasound probe positioned outside the body is used to deliver acoustic energy to a target volume inside the body. The treatment planning challenge is to deliver enough energy to coagulate the tissue within this volume, while leaving the surrounding areas unharmed. This equates to solving an optimization problem using coupled acoustic and thermal equations. The acoustic part is complicated by the fact the tissue is heterogeneous, the wave propagation is nonlinear, and the domain size can be on the order of thousands of wavelengths. This talk will focus on recent work to develop large scale nonlinear ultrasound models based on the Fourier collocation pseudospectral method. First, the governing equations are derived, cognizant of the chosen numerical method. For example, power law acoustic absorption is modeled using a linear integrodifferential operator based on the fractional Laplacian. Next, the discretization is discussed, including the use of a dispersion correction term derived from an analytical solution of the prototypical equation. Finally, results from simulations with grid sizes up to 2048^3 are presented, and the computational challenges and applications to treatment planning are discussed. (Received September 10, 2012)

1085-35-191 **Sergey A Dyachenko*** (sdyachen@unm.edu). *Solitons in 3D Dipolar BEC with 1/r interatomic potential.* Preliminary report.

A special configuration of laser beams can produce 1/r interatomic potential in atoms of 3D BEC. The evolution of BEC of dipolar atoms can be modeled by 3D Nonlocal NLSE. This BEC has quite alot of remarkable properties, such as the existence of solitons and long range interaction between them. (Received September 10, 2012)

1085-35-221 **Zeev Sobol*** (z.sobol@swansea.ac.uk), Department of Mathematics, Swansea University, Swansea, SA2 8PP. *Smoothness of a (weak) solution to a generalized Forchheimer equation.*

The author presents a (local) estimate of the maximum of the gradient of a weak solution to a generalized Forchheimer equation. Then a bootstrapping allows for further smoothness of the solution. (Received September 10, 2012)

1085-35-229 **Gung-Min Gie*** (ggie@math.ucr.edu), 900 University Ave., Riverside, CA 92521, and **Makram Hamouda**, **James P. Kelliher** and **Roger Temam**. *Boundary layers of the Navier-Stokes equations.*

We study boundary layers of the Navier-Stokes equations at small viscosity, in a curved domain, under various boundary conditions. In this talk, using the curvilinear system adapted to the boundary, we will focus on the construction of an incompressible corrector. (Received September 10, 2012)

1085-35-248 **Matthew Pennybacker*** (pennybacker@math.arizona.edu), 617 N. Santa Rita Ave., P.O. Box 210089, Tucson, AZ 85721-0089. *Why Fibonacci: Pattern-Forming Fronts as a Model for Phyllotaxis.*

Phyllotaxis, or the regular arrangement of plant structures, is among the most striking of natural phenomena. Perhaps the best example of this is found among the seeds on the head of a sunflower. Counting the number of spirals in the clockwise and counter-clockwise directions at the outer edge of the head almost always yields two consecutive members of the Fibonacci sequence, and moving inward, a transition to smaller Fibonacci numbers.

Newell, et al, have recently developed a model for phyllotaxis based on the Swift-Hohenberg equation, a generic description of many pattern-forming systems. In this talk, I will show how phyllotactic patterns may be realized as a front solution to this model, including the transition rule that results in the Fibonacci sequence. I will then compare our results to those of previous geometric and discrete models of phyllotaxis. Finally, I will discuss how this result fits phyllotaxis into the larger picture of universal phenomena. (Received September 11, 2012)

1085-35-255 **Mimi Dai*** (mimi.dai@colorado.edu). *Norm inflation for Navier-Stokes equations with fractional Laplacian in Besov Spaces.*

We demonstrate that the solutions to the Cauchy problem for the three dimensional incompressible Navier-Stokes equation with fractional Laplacian $(-\Delta)^\alpha$ is ill-posed in the largest critical space $\dot{B}^{1-2\alpha}_{\infty,\infty}$, for $\alpha \in (1, 5/4)$. We construct arbitrarily small initial data in the Besov space which produces arbitrarily large solution after an arbitrarily short time. The intuition is from the construction method introduced by Bourgain and Pavlović for Navier-Stokes equations. (Received September 11, 2012)

1085-35-287 **Kiril Datchev**, **Hamid Hezari** and **Ivan Ventura*** (iventura@math.arizona.edu). *Spectral uniqueness of radial semiclassical Schrödinger operators.*

We prove that the spectrum of an n-dimensional semiclassical radial Schrödinger operator determines the potential within a large class of potentials for which we assume no symmetry or analyticity. Our proof is based on the first two semiclassical trace invariants and on the isoperimetric inequality. (Received September 11, 2012)

1085-35-289 **j. Adrian Espinola-Rocha*** (jaer@cimat.mx), Callejon Jalisco s/n, Col Mineral de Valenciana, 36240 Guanajuato, Guanajuato, Mexico, and **Pablo Padilla-Longoria** (pablo@mym.iimas.unam.mx), Circuito Escolar, Ciudad Universitaria, 04510 Mexico, D.F., Mexico. *Viscosity solutions for the Hamilton-Jacobi equation with Toda potentials.* Preliminary report.

We consider the Hamilton-Jacobi equation with the corresponding potential to the integrable Toda lattice. We look for weak solutions, namely, viscosity solutions by means of the Lax formula. (Received September 11, 2012)

1085-35-290 **Mark S. Ashbaugh*** (ashbaughm@missouri.edu), Department of Mathematics, Mathematical Sciences Building, University of Missouri, Columbia, MO 65211-4100. *Inequalities for the First Eigenvalue of the Vibrating Clamped Plate under Compression.* Preliminary report.

This is a preliminary report on the question of finding good inequalities for the first eigenvalue of the vibrating clamped plate under (fixed) compression based on geometric considerations. In particular, we focus on the lowest eigenvalue of the clamped plate under compression among planar domains of fixed area, with specific emphasis on lower bounds. In mathematical terms, we consider the first eigenvalue of a certain 4th order partial differential operator with highest order term the biharmonic operator on bounded domains in two dimensions with clamped boundary conditions. We exhibit Rayleigh-type lower bounds for the first eigenvalue, which hold at least for small enough compression. The main results are the product of joint work with Rafael Benguria and Rajesh Mahadevan. (Received September 11, 2012)

37 ► Dynamical systems and ergodic theory

1085-37-22 **Gaetano Zampieri*** (gaetano.zampieri@univr.it), Dipartimento di Informatica, strada Le Grazie 15, 37134 Verona, Italy. *Some integrable Hamiltonian systems with isochrony or weakly unstable equilibria.*

Consider a smooth vector field f on an open set $A \subseteq R^n$. We say that $\phi : (-\infty, b) \to A$ is an *asymptotic motion* in the past to $\hat{x} \in A$, if $\phi(t)$ is a non-constant solution to $\dot{x} = f(x)$ such that $\phi(t) \to \hat{x}$ as $t \to -\infty$. Of course, the existence of such motions implies that $\hat{x}$ is unstable.

We focus on autonomous Hamiltonian systems. Our first aim is to clarify the concept of Lyapunov instability without asymptotic motions in the past that we briefly call *weak instability*. This is done by means of some examples. In particular we see that weakly unstable Hamiltonian equilibria can be linearly stable.

Our examples are four dimensional and integrable; they belong to a class which contains some rare superintegrable isochronous cases. To identify the non-isochronous unstable cases we show *necessary conditions for isochrony*.

The second aim of the talk is to show some *explicit global isochronous centers* for the scalar equation $\ddot{x} = -g(x)$, $g(0) = 0$, $g'(0) > 0$, on the whole plane.

Gaetano Zampieri, Completely integrable Hamiltonian systems with weak Lyapunov instability or isochrony, *Commun. Math. Phys.* **303** (2011) 73–87. (Received July 16, 2012)

1085-37-24 **Guillermo Davila-Rascon*** (gdavilar@gmail.com), Blvd. Luis Encinas y Rosales, Centro, 83000 Hermosillo, Sonora, Mexico. *Hamiltonian structures for two-frequency systems and the KAM setting.*

We describe Hamiltonian structures for two-frequency systems of the form

$$\dot{s}_i = \varepsilon f_i,$$
$$\dot{\varphi}_i = \omega_i + \varepsilon g_i, \qquad (i = 1, 2),$$

on phase space $T^*\mathbb{T} = \mathbb{R}^2 \times \mathbb{T}^2$ with coordinates $\big(s_1, s_2, \varphi_1 (\mathrm{mod}\, 2\pi), \varphi_2 (\mathrm{mod}\, 2\pi)\big)$ and arbitrary frequency vector (ω_1, ω_2). Here, $\varepsilon \ll 1$ is a perturbation parameter; $\omega_1 = \omega_1(s_1, s_2)$, $\omega_2 = \omega_2(s_1, s_2)$ and $f_i = f_i(s_1, s_2, \varphi_1, \varphi_2)$, $g_i = g_i(s_1, s_2, \varphi_1, \varphi_2)$ are smooth functions on $\mathbb{R}^2$ and $\mathbb{R}^2 \times \mathbb{T}^2$, respectively.

We are especially interested in systems for which the compatibility condition

$$\frac{\partial \omega_1}{\partial s_2} = \frac{\partial \omega_2}{\partial s_2},$$

not necessarily holds. Some aspects of the perturbation theory for such systems is discussed in the context of the KAM theorem. (Received July 16, 2012)

1085-37-52 **Luan T Hoang** (luan.hoang@ttu.edu), Department of Mathmatics and Statistics, Lubbock, TX 79409, **Akif Ibragimov** (akif.ibraguimov@ttu.edu), Department of Mathmatics and Statistics, Lubbock, TX 79409, and **Thinh T Kieu*** (thinh.kieu@ttu.edu), 4306 16th Street Quaker Pines Apt#5, Lubbock, TX 79416. *Steady states and linearization of the one-dimensional Forchheimer equation for incompressible immiscible two-phase flows.*

We derive a non-linear system of parabolic equations to describe the hydrodynamics of the one-dimensional two-phase Forchheimer flows of incompressible, immiscible fluids in porous media, in the presence of capillary forces. Under relevant constraints on relative permeabilities and capillary pressure, non-constant steady state solutions are found and classified into six-teen types according to their monotonicity and asymptotic behavior. For a steady state whose saturation can never attain either value 0 or 1, we prove that it is stable with respect to a certain weight function. Such a weight function is comprised of the steady state, relative permeabilities and capillary pressure. The proof is based on specific properties of the steady state, weighted maximum principle and Bernstein's estimate. (Received September 05, 2012)

1085-37-170 **Barbara A. Shipman**, Arlington, TX , and **Patrick Shipman*** (shipman@math.colostate.edu), 1874 Campus Delivery, Colorado State University, Fort Collins, CO 80523-1874. *Integrable Motions of Surfaces in Euclidean and Lorentzian Space: Constructions and Lie-Algebraic Setting.* Preliminary report.

The immersion of a surface into 3-dimensional Euclidean space has been related to surfaces Lie groups and Lie algebras by Fokas Gelfand. We extend this formalism to construct classes of integrable motions of surfaces in Euclidean and Lorentz space. (Received September 09, 2012)

1085-37-233 **Francis C Motta*** (motta@math.colostate.edu), 101 Weber Building, Colorado State University, Weber 234, Fort Collins, CO 80523-1874, **Bethany Springer** (springer@math.colostate.edu), 101 Weber Building, Colorado State University, Weber 234, Fort Collins, CO 80523-1874, and **Patrick D Shipman** (shipman@math.colostate.edu), 101 Weber Building, Colorado State University, Weber 121, Fort Collins, CO 80523-1874. *A Measure of Orbit Ergodicity.* Preliminary report.

For a fixed discrete-time dynamical system, $\Phi(x) : M \to M$ defined on a compact manifold, we introduce a function $E : \{\gamma_x | x \in M\} \to \mathbb{R} \cup \{\infty\}$ on the orbits of Φ, $\gamma_x := \{\Phi^t(x) | t \in \mathbb{N}\}$, and interpret $E(\gamma_x)$ as a measure of the orbit's ergodicity. In particular, motivated by phyllotactic patterns and problems in mixing, we study the family of dynamical systems $R_\theta : [0,1) \to [0,1)$ $(\theta \in (0,1))$ defined by $R_\theta(x) = (x + \theta) \mod 1$. Utilizing a recursive formula derived from the three-distance theorem, we compute the exact value of $E(\{R_\phi^t(x) | t \in \mathbb{N}\}, x \in [0,1))$, where $\phi = (\sqrt{5} - 1)/2$. We compare this to numerical approximations of $E(\{R_\theta^t(x) | t \in \mathbb{N}\}, x \in [0,1))$ for other values of θ and discuss how this measure distinguishes the ergodic behavior of different choices of (irrational) θ. We extend these results to other ergodic systems defined on $[0,1)$. (Received September 10, 2012)

1085-37-239 **Rafail V Abramov***, Mathematics, Statistics and Computer Science, 322 SEO, 851 S. Morgan st. (M/C 249), Chicago, IL 60607. *A simple closure approximation for slow dynamics of a multiscale system: nonlinear and multiplicative coupling.*

In this work we develop a new method for reduced models of multiscale systems, based on the linear fluctuation-dissipation theorem applied to statistical states of the fast variables. The method is suitable for situations with quadratically nonlinear and multiplicative coupling. We test the new method on the two-scale Lorenz 96 system and show that, with complex quadratically nonlinear and multiplicative coupling in both slow and fast variables, the reduced model produces comparable statistics to what is exhibited by the original two-scale system. (Received September 10, 2012)

1085-37-288 **Benno Rumpf*** (brumpf@smu.edu), Southern Methodist University, Department of Mathematics, 208 Clements Hall, Dallas, TX 75275-0156. *Spontaneous Breaking of the Spatial Homogeneity Symmetry in Wave Turbulence and the Emergence of Coherent Structures.*

Spatial homogeneity, the symmetry property that all sta- tistical moments are functions only of the relative geometry of any configuration of points, can be spontaneously broken by the instability of the finite flux Kolmogorov-Zakharov spectrum in certain (usually one dimensional) situations. As a result, the nature of the statistical attractor changes dramatically, from a sea of resonantly interacting disper- sive waves to an ensemble of coherent radiating pulses. (Received September 11, 2012)

41 ► Approximations and expansions

1085-41-144 **Plamen Simeonov*** (simeonovp@uhd.edu), Computer and Mathematical Sciences Dept., One Main Street, Houston, TX 77002, and **Mourad E. H. Ismail** (mourad.eh.ismail@gmail.com), 4000 Central Florida Blvd., P.O. Box 161364, Orlando, FL 32816-1364. *Asymptotics of Integrals of Products of Orthogonal Polynomials Arising in Combinatorics.* Preliminary report.

We derive the asymptotics of several integrals involving products of orthogonal polynomials when a certain parameter tends to infinity. The orthogonal polynomials considered include the Hermite, q-Hermite, and Chebyshev polynomials and the corresponding integrals have certain combinatorial interpretations. The asymptotic results are used to compute the probability of having certain configurations when the number of components is large. (Received September 07, 2012)

44 ► Integral transforms, operational calculus

1085-44-182 **Linh V Nguyen*** (lnguyen@uidaho.edu), Department of Mathematics, University of Idaho, 875 Perimeter Drive MS 1103, Moscow, ID 83844. *On the spherical mean transform arising in thermo-acoustic tomography.*

We consider the spherical mean transform on the set of spheres whose centers belong to a hyper-surface in a Euclidean space. The transform has been intensively studied recently due to its various applications, especially in thermo-acoustic tomography (TAT). In this talk, we will discuss recent progresses on the problems of inverting the transform and characterizing its range. (Received September 10, 2012)

1085-44-215 **Jürgen Frikel*** (juergen.frikel@helmholtz-muenchen.de), Institute of Biomathematics and Biometry, Helmholtz Zentrum München, Ingolstädter Landstraße 1, 85764 Neuherberg, Germany, and **Frank Filbir** and **Hrushikesh Mhaskar**. *Spectral methods for image reconstruction from spherical means.*

In various models of photoacoustic tomography, the reconstruction problem amounts to the inversion of the spherical mean Radon transform. For this purpose, many different exact inversion formulas have been developed. In order to apply these inversion formulas in practice, some discretization procedure has to be applied, such that only an approximate solution can be reconstructed. In this talk we investigate the discretization of series expansion methods for the inversion of the spherical mean Radon transform in an approximation theoretic setting. In particular, we will show that by applying spectral methods to discretization of series expansions, optimal convergence rates can be achieved. Moreover, we shall also outline that these discretization schemes may also be applied in situations where the spherical mean data data is (scattered) available on scattered points. (Received September 10, 2012)

45 ► Integral equations

1085-45-196 **Christopher Strickland*** (strickla@math.colostate.edu), 101 Weber Building, Colorado State University, Fort Collins, CO 80523, and **Patrick Shipman** and **Gerhard Dangelmayr**. *Modeling the nonlocal dispersal of invasive plant species in heterogeneous landscapes.*

Mathematical models for the spread of biological organisms typically utilize population growth and dispersal dynamics in an attempt to predict an expected value of the population distribution at some point in the future. These models often ignore uncertainty in initial conditions, neglect ecological heterogeneity in the landscape,

and even misrepresent the underlying stochastic growth and dispersal processes they are supposed to represent. Assuming the underlying population dynamics of an invasive plant can be described by a nonlinear, stochastic contact birth process, we develop a deterministic model for the probability of species presence as a function of time and space. While assuming no information about the relative size of the current population, our model focuses on the goal of species presence prediction resulting in a model that naturally incorporates heterogeneity in the landscape as well as uncertainty in initial conditions. (Received September 10, 2012)

46 ► Functional analysis

1085-46-166 **Alexander A. Katz*** (katza@stjohns.edu), St. John's University, St. John's College, Dep. of Math & CS, 300 Howard Ave., DaSilva AC 314, Staten Island, NY 10301. *On the weak nonstandard hulls of JB-algebras.*

In the paper, using Ng's approach, we construct a weak nonstandard hull of a JB-algebra and show that it is always a JBW-algebra. (Received September 08, 2012)

47 ► Operator theory

1085-47-114 **Evans M Harrell*** (harrell@math.gatech.edu), School of Mathematics, Georgia Institute of Technology, Atlanta, GA 30332-0160, and **Joachim Stubbe** (joachim.stubbe@epfl.ch), EPFL, IMB-FSB, Station 8, 1015 Lausanne, Switzerland. *Sum rules, spectral statistics, and eigenvalue bounds for graph Laplacians.*

We consider the spectra of three self-adjoint matrices associated with a combinatorial graph, viz., the adjacency matrix, the graph Laplacian, and the normalized graph Laplacian. Using identities for traces of operators and Chebyshev's inequality, we present some bounds on gaps, sums, Riesz means, and the statistical distribution of eigenvalues of these operators, and relate them to the structure of the graph. (Received September 04, 2012)

1085-47-118 **Waleed K. Al-Rawashdeh*** (walrawashdeh@mtech.edu), Department of Mathematical Sciences, Montana Tech, 1300 W. Partk Street, Butte, MT 59701. *Composition Operators between Weighted Bergman and S^p Spaces.*

Let φ be an analytic self-map of open unit disk $\mathbb{D}$. The operator given by $(C_\varphi f)(z) = f(\varphi(z))$, for $z \in \mathbb{D}$ and f analytic on $\mathbb{D}$ is called composition operator. 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 composition operators act between weighted Bergman A^p_α and S^q spaces, $1 \leq p, q < \infty$. Moreover, we give a lower bound for the essential norm of composition operator from A^p_α into S^q spaces, $1 \leq p \leq q$. (Received September 05, 2012)

1085-47-272 **Rod Freed*** (rfreed@csudh.edu), 4265 Marina City Drive #211, Marina del Rey, CA 90292. *Properties of the Ultraweakly Continuous Part of the Decomposition of a Positive Linear Functional.*

Let R be a von Neumann algebra, let f be a faithful state of R, and let fu + fs be the decomposition of f into its ultraweakly continuous and singular parts. We show that fu is a faithful, normal, positive linear functional on R. (Received September 11, 2012)

49 ► Calculus of variations and optimal control; optimization

1085-49-27 **Narayan Thapa*** (narayan.thapa@minotstateu.edu), Minot State University, Department of Mathematics and CS, 500 University Avenue West, Minot, ND 58707, and **Justin Ziegler** and **Carson Moen**. *Existence of Optimal Parameters for the Black-Scholes Option Pricing Model.*

In this paper we study parameters associated with the Black-Scholes option pricing model. The existence, uniqueness, and continuous dependence of the weak solution of the Black-Scholes model are established. The existence of optimal parameters is established. (Received July 27, 2012)

1085-49-143 **Giorgio Bornia*** (giorgio.bornia@ttu.edu), 2500, Broadway St., Lubbock, TX 79409-1042. *Lifting function approach for boundary optimal control problems in incompressible Magnetohydrodynamics.*

Optimal control problems for the incompressible Magnetohydrodynamics (MHD) equations are of great interest due to a wide range of possible applications involving electrically conductive fluids, such as aluminum casting in metallurgy and crystal growth in semiconductor industry. In such applications it may be a great improvement to achieve the control on the fluid state variables through the action of the magnetic Lorentz force. In this talk we consider a class of MHD boundary optimal control problems, in which the flow is controlled with the boundary conditions of the magnetic field. We propose a new approach for the formulation of these problems based on lifting functions of inhomogeneous boundary conditions. This approach yields both theoretical and numerical advantages. The optimal control problems under consideration are formulated in terms of the minimization of a cost functional with the nonlinear constraints of the Navier-Stokes and MHD equations. The Lagrange multiplier principle is used to derive an optimality system, whose numerical solution is a challenging task. We describe the algorithms and computational methodologies and we illustrate some numerical results in order to show that optimal solutions can be computed in an effective manner with the considered approach. (Received September 07, 2012)

1085-49-145 **Chiu-Yen Kao*** (kao@math.ohio-state.edu). *Shape Optimization Involving Eigenvalues of Laplace-Beltrami Operator.*

In this talk, an efficient algorithm is presented for shape optimization involving eigenvalues of Laplace-Beltrami operator. The closest point method is adapted to solve the forward eigenvalue problems on surfaces in a simple and efficient way. The optimal shape is achieved by an iterative method based on the efficient rearrangement algorithm. Unlike classical iterative approaches based on shape or topological derivative, the new method can obtain the optimal shape in just a few iterations. (Received September 07, 2012)

1085-49-180 **Rongjie Lai*** (rongjiel@usc.edu), 3620 S. Vermont Ave., KAP 104, Los Angeles, CA 90089, and **Jian Liang**, **Tsz Wai Wong** and **Hongkai Zhao**. *Geometric Understanding of Point Clouds Using Laplace-Beltrami Operator.*

In many problems in science and engineering, data is commonly represented as a collection of points, referred as a point cloud, sampled from a k-dimensional manifold in an n-dimensional space. Analyzing and inferring the underlying structure from the point clouds is critical in many fields such as 3D modeling, face recognition, image processing, manifold learning, computational biology etc. However, it is a challenge to extract global and nonlinear information hidden in the point clouds due to the lack of global connectivity. In our recent work, two systematical methods are proposed to solving PDEs on point clouds. We use the proposed methods to define the Laplace-Beltrami (LB) operator on point clouds, which provides us a bridge to link local and global information together. With this operator, we propose a few key applications to geometric understanding for point clouds, including computation of LB eigen-systems for point clouds, extraction of global skeletons structure from point clouds, extraction of conformal structures from point clouds, and intrinsic comparisons among point clouds. (Received September 10, 2012)

1085-49-278 **Braxton Osting*** (braxton@math.ucla.edu), 405 Hilgard Avenue, Los Angeles, CA 90095, and **Chiu-Yen Kao** (chiu-yen.kao@claremontmckenna.edu), Claremont, CA 91711. *Minimal convex combinations of sequential Laplace-Dirichlet eigenvalues.*

Minimal convex combinations of sequential Laplace-Dirichlet eigenvalues

We propose a computational approach based on the level set method to solve shape optimization problems where the objective function is dependent on the Laplace-Dirichlet eigenvalues of the domain. The approach is applied to the parameterized problem of minimizing the convex combination of sequential Laplace-Dirichlet eigenvalues. We show that as a function of the combination parameter, the optimal value is non-decreasing, Lipschitz continuous, and concave and that the minimizing set is upper hemicontinuous. The domains which minimize the first few Laplace-Dirichlet eigenvalues are known analytically and/or have been studied computationally and it is known that the optimal solution for some values have multiply connected components. Our computations reproduce these previous results for the appropriate parameter values and extend these results, effectively capturing intermediate topology changes. The results are also compared to values obtained analytically for rectangular and elliptical shapes and to values for domains with nearly-circular boundary. (Received September 11, 2012)

51 ► Geometry

1085-51-260 **Raquel Perales*** (praquel@math.sunysb.edu) and **Christina Sormani**. *"Sequences of Open Riemannian Manifolds with Boundary".*

Gromov proved that sequences of compact manifolds, M_j^m, with a uniform upper bound on their diameters and $Ricc \geq 0$ have subsequences which converge in the Gromov-Hausdorff sense. If there is a sequence of balls $B(p_j, r) \subset M_j$ with a uniform lower bound on volume, we say the sequence is noncollapsing and Colding has proven the volume converges.

This is false for open manifolds with boundary, as can be seen by taking k-fold covering spaces of $Ann_{1/k,1}(0) \subset \mathbb{E}^2$, which are flat spaces with diameter $\leq 2+\pi$ and volume $k(\pi 1^2 - \pi(1/k)^2)$ diverging. With my doctoral advisor, Christina Sormani, we have proven that if M_j^m is a noncollapsing sequence of open manifolds with boundary with $Ricc \geq 0$, a uniform upper bound on volume and a uniform upper bound on the intrinsic diameter of

$$M_j^\delta = \{x \in M_j : d_{M_j}(x, \partial M_j) > \delta\}$$

, then a subsequence of M_j^δ converge in the G-H sense with respect to the restricted metric. We are currently exploring the properties of the limit space. Prior research on the convergence of manifolds with boundary imposing conditions on the curvature of the boundary has been conducted by Wong and by Kodani. Here we do not even require a smooth boundary. (Received September 11, 2012)

1085-51-271 **Ian Biringer*** (ianbiringer@gmail.com). *Extension into handlebodies and limits of Kleinian groups.*

We will discuss work with Johnson-Minsky and Lecuire concerning the extension of homeomorphisms of the boundary of a handlebody into its interior. Although the motivation is topological, our techniques come from 3-dimensional hyperbolic geometry. (Received September 11, 2012)

53 ► Differential geometry

1085-53-5 **Guofang Wei*** (wei@math.ucsb.edu), Department if Mathematics, UCSB, Santa Barbara, CA 93106. *Comparison Results for Ricci Curvature.*

Ricci curvature occurs in the Einstein equation, Ricci flow, optimal transport, and is important both in mathematics and physics. Comparison method is one of the key tools in studying the Ricci curvature. We will start with Bishop-Gromov volume comparison, and then discuss some of its generalizations and their applications. (Received September 06, 2012)

1085-53-23 **Chris Kim*** (cmkim@umn.edu), 127 Vincent Hall, 206 Church St. S.E., Minneapolis, MN 55455. *Deforming Cylindrical Surfaces in Hyperbolic 3-manifolds by their Harmonic Mean Curvature.* Preliminary report.

We consider the harmonic mean curvature flow (HMCF) of axially symmetric surface around a closed geodesic in Hyperbolic 3-manifold. Assuming the initial surface is strictly convex and HMC $< 1/2$, we obtain the optimal asymptotic estimates of both principal curvatures: $\lambda_1 \approx e^{-t}, \lambda_2 \approx e^t$. The asymptotic shape of the surface as it converges to the closed geodesic is studied by rescaling the metric and showing that two principal curvatures $\tilde{\lambda}_1, \tilde{\lambda}_2$ and height function $\tilde{r}$ of the rescaled surface converge uniformly to 0, r_0^{-1}, and r_0, respectively, for some constant r_0. Analyzing the principal curvatures of evolving cylindrical surface presents a novel problem since we expect the small principal curvature to become zero and the large principal curvature to become infinity. The curvature estimates obtained in Theorem 4.1 of [Andrews94] and Theorem 5.1 of [Huisken84] for spherical hypersurfaces are no longer valid since they prove that the ratio of principal curvatures are uniformly bounded. We will have to estimate each principal curvature separately and also estimate their product, i.e. the Gauss curvature, which remains more or less constant throughout the evolution process. (Received July 16, 2012)

1085-53-60 **Matthew Stover*** (stoverm@umich.edu), Department of Mathematics, 530 Church Street, Ann Arbor, MI 48109. *The number of ends of hyperbolic n-manifolds.*

Let M be a noncompact finite volume complete hyperbolic n-manifold. Then M has a finite number $e(M)$ of topological ends. Examples with $e(M) = 1$ are easy to construct in dimensions 2 and 3, e.g., once punctured surfaces and knot complements in the 3-sphere, respectively. No examples are known $n \geq 4$, and 1-ended orbifolds were only known to exist for $n \leq 9$. I will discuss the proof of the following theorem: 1-ended arithmetic hyperbolic n-orbifolds do not exist for $n \geq 30$. This is a consequence of a more general result, namely, that for any fixed $k > 0$, the number of arithmetic negatively curved locally symmetric spaces N with $e(N) = k$ fall into finitely many commensurability classes. (Received August 28, 2012)

1085-53-68 **Fernando A Schwartz*** (fernando@math.utk.edu), Department of Mathematics, University of Tennessee, 227 Ayres Hall, 1403 Circle Drive, Knoxville, TN 37996-1320. *Geometric inequalities for hypersurfaces.*

We revisit some classic estimates for the capacity as well as a version of the Alexandrov-Fenchel inequality for hypersurfaces of Euclidean space. We provide new, more general proofs of these inequalities, and include some rigidity statements. The results are joint work with Alexandre Freire. (Received August 29, 2012)

1085-53-83 **Lee Kennard*** (kennard@math.ucsb.edu). *On the Hopf conjectures with symmetry.*

We will discuss some Betti number obstructions to the existence of positively curved metrics with large symmetry. As applications, we provide evidence for the two conjectures of Hopf in the presence of symmetry. (Received August 31, 2012)

1085-53-113 **Jeanne Clelland*** (jeanne.clelland@colorado.edu), Dept. of Mathematics, 395 UCB, University of Colorado, Boulder, CO 80309-0395, and **Edward Estrada**, **Molly May**, **Jonah Miller**, **Sean Peneyra** and **Michael Schmidt**. *A Tale of Two Arc Lengths.*

In Euclidean geometry, all metric notions (arc length for curves, the first fundamental form for surfaces, etc.) are derived from the Euclidean inner product on tangent vectors, and this inner product is preserved by the symmetry group of Euclidean space (translations, rotations, and reflections).

In equiaffine geometry there is no invariant notion of inner product on tangent vectors that is preserved by the full symmetry group of affine space. Nevertheless, it is possible to define an invariant notion of arc length for "nondegenerate" curves, and an invariant first fundamental form for "nondegenerate" surfaces in affine space. This leads to two possible notions of arc length for a curve contained in a surface, and these two arc length functions do not necessarily agree! In this talk we will explain all this, derive necessary and sufficient conditions under which the two arc length functions DO agree, and illustrate with lots of examples. (This is joint work with a group of independent study students.) (Received September 04, 2012)

1085-53-120 **Brett Kotschwar*** (kotschwar@asu.edu). *A short proof of uniqueness for the Ricci flow.*

We describe an elementary approach to the problem of uniqueness to the Ricci flow via the consideration of an appropriate energy functional. By this method we are able to avoid the auxiliary Ricci-DeTurck and harmonic map flows entirely, and strengthen the standard uniqueness result of Hamilton-Chen-Zhu to include a class of solutions of potentially unbounded curvature. (Received September 05, 2012)

1085-53-130 **William Wylie*** (wwylie@syr.edu), Mathematics Department, Syracuse University, 215 Carnegie Building, Syracuse, NY 13244. *Conformal Diffeomorphisms of Gradient Ricci solitons.*

It is well known that conformal changes do not preserve the Einstein condition. In fact, it is quite rigid when two Einstein metrics are conformal, and in the 1920s Brinkmann classified when this is possible. Yano-Nagano later showed that the only complete Einstein metric to admit a complete non-homothetic conformal field is the round sphere.

We extend these results to gradient Ricci solitons. In order to do so, we make the additional assumption that the conformal diffeomorphisms preserve the potential function (this assumption is always satisfied in the Einstein case as the potential function is constant). We show that the only non-homothetic conformal diffeomorphisms that preserve the potential function between complete shrinking or steady gradient Ricci solitons are the conformal transformations of the sphere and stereographic projection. We also show a complete gradient Ricci soliton admits a complete non-homothetic conformal field preserving the potential function if and only if it is the round sphere. These results are special cases of more general results for generalized quasi-Einstein metrics which will also be discussed.

This is joint work with Jeffrey L. Jauregui of UPenn. (Received September 06, 2012)

1085-53-150 **Michael Jablonski*** (mjablonski@math.ou.edu). *Towards the generalized Akeseevsky conjecture.*

The Strong Generalized Alekseevsky Conjecture asserts that a non-compact, non-trivial homogeneous Ricci soliton must be isometric to a solvsoliton - i.e. a solvable Lie group with left-invariant, algebraic Ricci soliton metric. In this talk, we report on recent progress towards the resolution of this conjecture. (Received September 07, 2012)

1085-53-153 **Sajjad Lakzian*** (slakzian@gc.cuny.edu). *Smooth Convergence Away From Singular Sets.*

Given a sequence of Riemannian metrics on a compact manifold, one can talk about different notions of convergence (or limits) of these Riemannian manifolds. We will consider the two most important notions of convergence namely, the Gromov-Hausdorff convergence (limit) and the Smooth Convergence (Away from singularities) of these metrics. We will provide conditions under which these two limits agree. (Received September 07, 2012)

1085-53-163 **Jeffrey S Case***, Department of Mathematics, Princeton University, Princeton, NJ 08544. *Conformal invariants measuring the best constants for Gagliardo-Nirenberg-Sobolev inequalities.*

In 2002, Del Pino and Dolbeault computed the best constants for a certain family of Gagliardo-Nirenberg-Sobolev inequalities of the form $\|w\|_p \leq C\|\nabla w\|_2^\theta \|w\|_q^{1-\theta}$ on $\mathbb{R}^n$, and moreover, showed that the extremal functions are powers of the extremals for the familiar case $p = 2n/(n-2)$. We introduce conformal invariants defined on smooth metric measure spaces which recover these sharp constants on Euclidean space, and use this perspective to characterize the special family found by Del Pino and Dolbeault. If time allows, we will also comment on the Yamabe-type problem of finding functions which minimize these invariants. (Received September 08, 2012)

1085-53-167 **Yuanqi Wang*** (wangyuanqi@math.ucsb.edu), Goleta, CA 93117. *On the Kähler-Ricci flow near a Kähler-Einstein metric.* Preliminary report.

This is a joint work with Song Sun. Motivated by recent study of the convergence of Calabi flow near a constant scalar curvature Kähler metric, we prove a similar theorem on the stability of the Kähler-Ricci flow near a Kähler-Einstein metric of positive scalar curvature. We will give an example on jumping of the complex structure under Ricci flow and discuss on the linear stability of Kähler Ricci solitons. (Received September 08, 2012)

1085-53-266 **Thalia D. Jeffres***, Wichita State University, Wichita, KS 67260, and **Klaus Kirsten** and **Tianshi Lu**. *Zeta Function on Surfaces of Revolution.*

In recently completed joint work with Klaus Kirsten and Tianshi Lu, we studied the zeta function on compact surfaces of revolution with boundary. We were able to calculate the values and residues of a meromorphic extension at values which are physically and geometrically significant. In particular, we obtained a formula in closed form for the derivative at zero of such an extension. This allows one to define the determinant of the Laplacian. (Received September 11, 2012)

55 ► Algebraic topology

1085-55-129 **Ralf Hielscher*** (ralf.hielscher@mathematik.tu-chemnitz.de). *The inversion of the Radon transform on the rotation group.* Preliminary report.

We are concerned with the inversion of the Radon transform on the rotation group. Since the inverse problem is overdetermined we consider a sampling that is restricted to a characteristic submanifold in the range of the Radon transform. We present fast algorithms for the forward problem as well as for the inverse problem. (Received September 06, 2012)

57 ► Manifolds and cell complexes

1085-57-2 **Michael Hutchings***, Mathematics Department, 970 Evans Hall, University of California, Berkeley, CA 94720. *Quantitative invariants in four-dimensional symplectic geometry.*

Given two symplectic manifolds of the same dimension, possibly with boundary, when does there exist a symplectic embedding of one into the other? A major breakthrough on this question was Gromov's nonsqueezing theorem from 1985, which shows that it is far from sufficient for the volume of one manifold to be less than the volume to the other. In 2012, the answer to this question is still unknown, or only recently known, even for simple examples of convex subsets in $\mathbb{R}^4$ such as ellipsoids and polydisks. In 2010, McDuff proved a subtle number-theoretic criterion for the existence of a symplectic embedding of one four-dimensional ellipsoid into another. The obstruction half of McDuff's theorem follows from the more general theory of "ECH capacities" of symplectic four-manifolds, which we will describe. This theory is also related to the dynamics of Reeb vector fields on contact three-manifolds. Taubes proved in 2006 that for every contact form on a closed three-manifold, the associated Reeb vector field has at least one periodic orbit (the three-dimensional Weinstein conjecture). In

joint work with Dan Cristofaro-Gardiner and Vinicius Gripp, we use ECH capacities to refine Taubes's result to show that there are at least two geometrically distinct periodic orbits. (Received September 11, 2012)

1085-57-51 **Ilesanmi Adeboye*** (iadeboye@wesleyan.edu). *Volume in Complex Hyperbolic Geometry.* Complex hyperbolic space is the complex analogue of (real) hyperbolic space. A complex hyperbolic orbifold is the quotient of complex hyperbolic space by a discrete group of isometries. In this talk, I will define the projective model of complex hyperbolic space. I will then prove an explicit lower bound for the volume of a complex hyperbolic orbifold, depending only on dimension. This is joint work with Guofang Wei. (Received August 23, 2012)

1085-57-115 **Igor Belegradek*** (ib@math.gatech.edu). *Obstructions to nonpositive curvature for open manifolds.*

We study algebraic conditions on a group G under which every properly discontinuous, isometric G-action on a Hadamard manifold has a G-invariant Busemann function. For such G we prove the following structure theorem: every open complete nonpositively curved Riemannian $K(G,1)$ manifold that is homotopy equivalent to a finite complex of codimension ≥ 3 is an open regular neighborhood of a subcomplex of the same codimension. In this setting we show that each tangential homotopy type contains infinitely many open $K(G,1)$ manifolds that admit no complete nonpositively curved metric even though their universal cover is the Euclidean space. A sample application is that an open contractible manifold W is homeomorphic to a Euclidean space if and only if $W \times S^1$ admits a complete Riemannian metric of nonpositive curvature. (Received September 04, 2012)

1085-57-121 **Francis Bonahon*** (fbonahon@math.usc.edu), University of Southern California, Los Angeles, CA 90089, and **Guillaume Dreyer**, University of Notre Dame, Notre Dame, IN 46556. *A parametrization of the Hitchin component.*

A closed oriented surface S of genus $g \geq 2$ can be endowed with many hyperbolic metrics, and these form the *Teichmüller space* $\mathcal{T}(S)$. The Teichmüller space is diffeomorphisc to $\mathbb{R}^{6(g-1)}$, and the map associating its monodromy to a hyperbolic metric identifies $\mathcal{T}(S)$ to a component of the space of all group homomorphisms from the fundamental group $\pi_1(S)$ to the Lie group $\mathrm{PSL}_2(\mathbb{R})$. The space of group homomorphisms $\pi_1(S) \to \mathrm{PSL}_n(\mathbb{R})$ similarly has a preferred component $\mathcal{H}_n(S)$, called its *Hitchin component*. Hitchin proved around 1990 that $\mathcal{H}_n(S)$ is diffeomorphic to $\mathbb{R}^{2(g-1)(n^2-1)}$. We will describe a more geometric parametrization of the Hitchin component $\mathcal{H}_n(S)$, which is somewhat reminiscent of the parametrization of the Teichmüller space $\mathcal{T}(S)$ by Fenchel-Nielsen coordinates. (Received September 05, 2012)

1085-57-185 **Jean-Francois Lafont** and **D. B. McReynolds*** (dmcreyno@math.purdue.edu), 150 N. University, West Lafayette, IN 47907. *Structure in spectral sets.*

The geodesic length spectrum and eigenvalue spectrum of the Laplacian are well known invariants of a Riemannian manifold. I will discuss some well known questions and results about these invariants. This will lead us to a new direction and I will discuss some recent work with Jean Lafont in this direction. (Received September 10, 2012)

58 ► Global analysis, analysis on manifolds

1085-58-18 **Igor Prokhorenkov*** (i.prokhorenkov@tcu.edu), Department of Mathematics, TCU Box 298900, Fort Worth, TX 76129, and **Ken Richardson** (k.richardson@tcu.edu), Department of Mathematics, TCU Box 298900, Fort Worth, TX 76129. *Witten deformation of transversal Dirac operators.* Preliminary report.

We classify Witten deformations of transversal Dirac operators on Riemannian foliations. We apply results to obtain information about the index of basic Dirac operators in terms of geometric invariants of the foliation. (Received July 14, 2012)

1085-58-62 **Ivan G Avramidi*** (iavramid@nmt.edu), Department of Mathematics, New Mexico Institute of Mining and Technology, 801 Leroy Place, Socorro, NM 87801, and **Samuel Collopy** (samuel.collopy@gmail.com), Department of Physics, New Mexico Institute of Mining and Technology, 801 Leroy Place, Socorro, NM 87801. *Yang-Mills Theory on Spheres.*

We study the one-loop effective action in Yang-Mills theory on spheres which is determined by determinants of two elliptic second-order Laplace type partial differential operators acting on sections of homogeneous vector bundles over spheres. We study the heat trace and the zeta function of these operators on spheres. We obtain

explicit formulas for the heat trace on S^2 and S^3. We show that the existence of negative modes is a general feature of these operators, which indicates the instability of the Yang-Mills theory on spheres. (Received August 28, 2012)

1085-58-105 **Jon Harrison*** (jon_harrison@baylor.edu). *Pseudo orbit expansions for quantum graphs.*
We investigate spectral quantities of quantum graphs by expanding them as sums over pseudo orbits, sets of periodic orbits. Unlike the trace formula, where the density of states is expressed as an infinite sum over all periodic orbits, only a finite collection of pseudo orbits which are irreducible and where the total number of bonds is less than or equal to the number of bonds of the graph appear. This is analogous to a cut off at half the Heisenberg time. The calculation simplifies previous approaches to pseudo orbit expansions on graphs. Using this approach we formulate coefficients of the characteristic polynomial, the spectral determinant and vacuum energy as finite expansions over the set of short irreducible pseudo orbits. This is joint work with Ram Band and Christopher Joiner (Bristol University, U.K.). (Received September 04, 2012)

1085-58-132 **Nishu Lal** and **Michel L. Lapidus*** (lapidus@math.ucr.edu), University of California, Department of Mathematics, Riverside, CA 92521-0135. *Laplacians on Self-Similar Fractals and Their Spectral Zeta Functions.*
We investigate the spectral zeta functions of certain fractal differential operators, such as fractal Sturm-Liouville operators acting on a self-similar interval (equipped with a given self-similar measure and Dirichlet form) and the fractal Laplacian on the unbounded (or infinite) Sierpinski gasket. In each case, using the so-called decimation method and its extension to several complex variables by C. Sabot, we obtain a factorization of the corresponding spectral zeta function, expressed (in general) in terms of a suitable hyperfunction, a geometric zeta function, and the zeta function associated with the iteration of a multi-variable rational function acting in complex projective space. The resulting factorization formula generalizes earlier work of the second author (for fractal strings), itself later extended by A. Teplyaev to the Laplacian on the finite (or bounded) gasket, in particular. In a very special case, we obtain a new dynamical interpretation of the Riemann zeta function. (Received September 06, 2012)

1085-58-169 **Don Colladay** (colladay@ncf.edu), Division of Natural Science, 5800 Bay Shore Road, Sarasorta, FL 34243, and **Patrick McDonald*** (mcdonald@ncf.edu), Division of Natural Science, 5800 Bay Shore Road, Sarasota, FL 34243. *Heat content, exit time moments and metric graphs.*
For smoothly bounded domains in a Riemannian manifold there are deep connections between the heat content of the domain, the Dirichlet spectrum of the domain and the average expected exit time moments for Brownian motion on the domain. For example, it is known that the average expected exit time moments for Brownian motion determine the heat content of the domain, and, for generic domains, heat content determines Dirichlet spectrum. We establish analogous results in the context of metric graphs. In addition, we discuss well known isospectral families of compact metric graphs which we show are distinguished by heat content. (Received September 09, 2012)

1085-58-227 **C. M. Guenther*** (guenther@pacificu.edu). *Second order renormalization group flow of three-dimensional homogeneous geometries.*
The second order nonlinear sigma model renormalization group flow from quantum field theory is given by

$$\frac{\partial}{\partial t}\mathrm{g} = -2\mathrm{Rc} - \frac{\alpha}{2}\mathrm{Rm}^2,$$

where g is a Riemannian metric, Rc is Ricci curvature, Rm is Riemannian curvature, and $\alpha > 0$ is a parameter. We determine the asymptotic behavior of the flow on closed three-dimensional locally homogeneous manifolds, and in particular its dependence on α and the initial data. We find that for $\mathbb{R}^3$, $\mathrm{SO}(3) \times \mathbb{R}$, and $\mathrm{SU}(2)$ the flow is qualitatively similar to the Ricci flow for all α. In each of the other cases we find an explicit partition of the phase space into two regions: if the initial conditions lie in one of the regions the behavior is similar to that of the Ricci flow, while if they lie in the other all directions shrink and a finite time singularity forms. (Received September 10, 2012)

1085-58-249 **Michael Bradford Williams*** (mwilliams@math.ucla.edu), UCLA Mathematics Department, Box 951555, Los Angeles, CA 90095-1555. *Stability of solutions of Ricci flow.*
Abstract: The Ricci flow is an important tool in geometry, and a main problem is to understand the stability and convergence of solutions of the flow. We describe a general technique for determining dynamical stability of fixed points of certain types of PDE, which has applications to Ricci flow and various related coupled systems. We also describe certain geometric conditions under which classes of fixed points–including Einstein metrics and Ricci solitons–are stable. (Received September 11, 2012)

1085-58-251 **Ruth Gornet** and **Ken Richardson*** (k.richardson@tcu.edu). *Eta Invariants on Nilmanifolds.*

The eta invariant appears regularly in index theorems but is known to be computable only in some examples of locally symmetric spaces of compact type. In this work, we study the eta invariant on nilmanifolds by decomposing the spin^c Dirac operator using Kirillov theory. Also, we derive some general formulas useful for calculating the eta invariant for an operator that has a point of symmetry in its spectrum. In particular, for general Heisenberg three-manifolds, the spectrum of the spin^c Dirac operator and the eta invariant are computed. The eta invariant satisfies

$$\eta(0) = \frac{r^2 m_v}{96\pi^2 A^2} - N(A, r, w_2, m_v, m_w, \varepsilon),$$

where $N(\cdot)$ is a nonnegative integer specified in terms of the metric, lattice, and spin structure data. There are continuous families of geometrically, spectrally different Heisenberg three-manifolds whose spin^c Dirac operators have constant eta invariant. In theory, we could calculate the Dirac spectrum for any Heisenberg nilmanifold of any dimension. We show that the Dirac spectrum is symmetric about zero in dimensions $4m+1$ ($m \in \mathbb{Z}_{\geq 0}$); thus, the eta invariant is automatically zero in these dimensions. (Received September 11, 2012)

1085-58-279 **Thomas Krainer*** (krainer@psu.edu), Penn State Altoona, Mathematics and Statistics, 3000 Ivyside Park, Altoona, PA 16601, and **Gerardo A. Mendoza** (gmendoza@temple.edu), Temple University, Department of Mathematics, 1805 N. Broad Street, Philadelphia, PA 19122. *On elliptic systems of pseudodifferential operators of variable order.* Preliminary report.

The analysis of well-posedness of elliptic PDEs on manifolds with incomplete edge metrics leads to the problem of defining what the trace with respect to a singular stratum should be for functions that belong to natural L^2-domains of the operator. It is known that this notion of trace is connected with establishing asymptotic expansions for functions into singular functions whose leading terms are determined by the indicial roots of the operator with respect to the stratum. The coefficients of these expansions are functions on the stratum that represent the desired traces. A serious issue is when the indicial roots vary along the stratum. Locally, the coefficient functions on the stratum then have variable smoothness.

In this talk I will present a pseudodifferential calculus that is tailored for the purpose of analyzing such traces. This calculus has a notion of ellipticity and admits parametrices for elliptic systems of variable order. There is a Fredholm and index theorem in associated Sobolev spaces of sections of bundles of variable smoothness. The calculus and resulting function spaces furnish the setup for studying well-posedness of elliptic PDEs on manifolds with incomplete edges.

The research is partially supported by NSF grants DMS-0901202 and DMS-0901173. (Received September 11, 2012)

1085-58-293 **Paul Loya*** (loya@math.binghamton.edu) and **Klaus Kirsten** (klaus_kirsten@baylor.edu). *Casimir's surgery problem.*

In 1948, Hendrik Casimir published a surprising result using "analytic surgery" for manifolds with corners (specifically a solid three-dimensional box, which is a manifold with corners of codimension three). In previous work, Klaus Kirsten and I derived a Casimir-type surgery formula in the case of smooth manifolds; this formula unfortunately does not apply to Casimir's original situation. However, in this talk, joint with Kirsten, I will present Casimir's surgery formula in full generality for manifolds with corners of any codimension. This in particular applies to Casimir's original situation and from our formula we can explain the origin and meaning of the mysterious constants that appear in Casimir's original formula. (Received September 12, 2012)

60 ► Probability theory and stochastic processes

1085-60-32 **Manfred Denker*** (denker@math.psu.edu). *Random Countable Markov Shifts.*

The talk reviews some properties of random topological Markov shifts: thermodynamic formalism, random Gibbs measures and exactness (triviality of tail fields). This is based on on a joint work with Y. Kifer (Hebrew University) and M. Stadlbauer (Federal University of Bahia). (Received August 08, 2012)

1085-60-37 **Jorge M Ramirez*** (jmramirezo@unal.edu.co), Calle 59A No 63-20, Bloque 43 - 242, Medellin, Antioquia 05001000, Colombia. *Diffusion processes on graphs: construction and applications.*

Consider a graph Γ consisting of infinite edges e_0, e_1, e_2 joined at node ϕ. A function $f : \Gamma \to \mathbb{R}$ is specified by its restrictions $f_i : [0, \infty) \to \mathbb{R}$ to each of the edges. For positive, non-zero numbers D_i, $i = 0, 1, 2$, we consider

parabolic operators acting on functions over Γ. One example is the operator A given by $(Af)_i = D_i f_i''$ acting on functions that are smooth inside each edge of Γ, and satisfy the flux condition $\sum_i D_i f_i'(0^+) = 0$, at node ϕ. The associated stochastic process $\{X(t) : t \geq 0\}$ is a Feller process on Γ that has A as its infinitesimal generator. The sample paths of X behave like (appropriately re-scaled) Brownian motion inside each edge, but have different transition probabilities from the node into each of the adjoining edges, generalizing the notion of "skew Brownian motion" to a graph. Application examples include dispersion phenomena in river systems, blood vessels, and electrical networks. In this talk we also consider, in particular, the case where the diffusion process contains a non-zero advection term, e.g. $(Af)_i = D_i f_i'' + v_i f'$. (Received August 14, 2012)

1085-60-43 **Mark I. Freidlin*** (mif@math.umd.edu), Department of Mathematics, University of Maryland, College Park, MD 20742. *Perturbation Theory for Systems with Multiple Stationary Regimes.*

Perturbations of a system with multiple stationary regimes (multiple invariant measures) lead, in an appropriate time scale, to a motion in the space of invariant measures. This motiopn determine the long-time evolution of the perturbed system. Extreme pointes of the cone of invariant measures can be parameterized, under certain conditions, by the points of a graph or its multidimensional counterpart- an open book. So that the long time evolution is described by a (in general, stochastic even in the case of pure deterministicperturbations) process on the graph. I will consider applications of this general approach to systems with relatively simple set of invariant measures: to one-degree-of-freedom oscillator, to area preserving systems on 2-torus, to the Landau-Lifshitz magnetization equation, to processes in narrow channels, and (if time permits) to second order elliptic equations with a small parameter in higher derivatives. (Received August 18, 2012)

1085-60-45 **Enrique Thomann*** (thomann@math.oregonstate.edu), Department of Mathematics, Kidder Hall, 370B, Oregon State University, Corvallis, OR 97331, **Thilanka Appuhamillage**, OR, **Vrushali Bokil**, OR, **Edward Waymire**, OR , and **Brian Wood**, OR. *Local Time and Interfacial Phenomena.*

A variety of problems from biological and geophysical sciences naturally lead to consideration of the effect of sharp interfaces in macroscopic quantities such as for example, residence time and first passage time. In this talk we will illustrate the relation between properties of local time and different interface conditions. The notion of 'natural' local time will be introduced and continuity properties of this local time will be discussed. (Received August 20, 2012)

1085-60-65 **Bjorn Birnir*** (birnir@math.ucsb.edu), Dept. of Math, Univ. of California, Santa Barbara, Santa Barbara, CA 93117. *The Kolmogorov-Obukhov Statistical Theory of Turbulence.*

In 1941 Kolmogorov and Obukhov proposed that there exists a statistical theory of turbulence that should allow the computation of all the statistical quantities that can be computed and measured in turbulent systems. These are quantities such as the moments, the structure functions and the probability density functions (PDFs) of the turbulent velocity field. In this talk we will outline how to construct this statistical theory from the stochastic Navier-Stokes equation. The additive noise in the stochastic Navier-Stokes equation is generic noise given by the central limit theorem and the large deviation principle. The multiplicative noise consists of jumps multiplying the velocity, modeling jumps in the velocity gradient. We first estimate the structure functions of turbulence and establish the Kolmogorov-Obukhov '62 scaling hypothesis with the She-Leveque intermittency corrections. Then we compute the invariant measure of turbulence writing the stochastic Navier-Stokes equation as an infinite-dimensional Ito process and solving the linear Kolmogorov-Hopf functional differential equation for the invariant measure. Finally we project the invariant measure onto the PDFs. (Received August 29, 2012)

1085-60-78 **Gopal K Basak***, Stat-Math Unit, 203 B. T. Road, Indian Statistical Institute, Kolkata, India, and **Arunangshu Biswas** (arunb12002@gmail.com), Presidency University, Kolkata, India. *TITLE Adaptive MCMC with a random scaling parameter as a tuner and diffusion approximation.*

ABSTRACT

Adaptive Markov Chain Monte Carlo (AMCMC) is a class of algorithms that has been recently proposed in MCMC literature. In the AMCMC, there is a tuning parameter, in this case a scaling parameter, which is a function of the previous sample paths. Thus, it is a random variable that changes according to samples chosen. Also, the chain moves along with scaling parameter. This scaling parameter determines how fast the simulation converges to the desired distribution, say ϕ. However, this destroys the Markovian structure of the chain.

In the present work, the use of diffusion approximation technique on the discrete time AMCMC gives rise to a Ornstein-Uhlenbeck type diffusion with a random scaling parameter that satisfy a differential equation. Viewing it together as a two dimensional singular diffusion, and going through Hormander's hypoelliipticity and tightness the existence of smooth density is observed. Further moment bounds are achieved to use stein's idea to recover the desired distribution ϕ as the marginal of the two-dimensional invariant distribution. Further, some simulations are done for various distribution to compare the Adaptive with the Non-Adaptive or Standard MCMC. (Received August 31, 2012)

1085-60-84 **Davar Khoshnevisan*** (davar@math.utah.edu), Department of Mathematics, University of Utah, 155 South 1400 East, Salt Lake City, UT 84112. *Some Very Rough Differential Equations.* Preliminary report.

We consider differential equations of the type $dY = f(Y)dX$, where $X = X(t)$ is very rough and f is Lipschitz continuous. Among other things we prove weak existence of a solution in the case that X is fractional Brownian motion of Hurst index $H \leq 1/4$. More significantly, we describe the law of our solution. The surprising fact is that the solution is connected intimately to certain equations of random media. Time permitting, we will show how the analogue of "the stochastic exponential of fBm(1/4)" is the solution to "KPZ."

This is based on various ongoing collaborative projects with Jason Swanson, Yimin Xiao, and Liang Zhang. (Received September 01, 2012)

1085-60-101 **Nicolas Lanchier*** (lanchier@asu.edu), School of Mathematical and Statistical Scienc, Arizona State University, Tempe, AZ 85287. *Stochastic spatial model of producer-consumer systems.*

The objective of this talk is to give a rigorous analysis of a stochastic spatial model of producer-consumer systems in order to understand the role of space in ecological communities in which individuals compete for resources. Each point of the square lattice is occupied by an individual which is characterized by one of two possible types. Each individual being thought of as a producer and consumer of resources, the new type at each update is chosen at random from a certain interaction neighborhood according to probabilities proportional to the ability of the neighbors to consume the resource produced by the individual to be updated. Our results indicate that the nonspatial deterministic mean-field approximation of this stochastic process fails to describe the behavior of the system in the presence of local interactions. In particular, in the parameter region where the nonspatial model displays bistability, there is a dominant type that wins regardless of its initial density in the spatial model. The inclusion of space also translates into a significant reduction of the parameter region where both types coexist. (Received September 03, 2012)

1085-60-119 **Larry Winter*** (winter@email.arizona.edu), 1133 East James E. Rogers Way, Tucson, AZ 85721, **Jeffrey Hyman** (jhyman@math.arizona.edu), Tucson, AZ 85721, and **Piotr Smolarkiewicz**, Boulder, CO 80307. *Computational Physics of Fluid Flow Through Explicit Pores Spaces.*

The advent of high-performance computers and advanced fluid dynamics simulators permits computational experiments with flow through realistic three-dimensional pore spaces that are equivalent in accuracy to physical experiments while yielding unprecedented levels of detail about the properties of flow fields. Flow through samples of explicit pore-spaces can be simulated efficiently while reproducing key physics by combining non-oscillatory (viz. high-resolution) Navier-Stokes integrators with semi-implicit representation of elementary (first-order) immersed-boundary forcing, since the macroscopic uncertainty of the flow regime greatly exceeds numerical inaccuracies in detailed representation of internal boundaries [Smolarkiewicz & Winter, J. Comput. Phys. 229 (2010) 3121]. In this talk, we compute attributes of particle trajectories including tortuosity, trajectory length, and first passage percolation time. The fluid velocity fields become more homogeneous with rising porosity indicated by a decrease in the variance of tortuosity, trajectory length, and travel time distributions. A nonlinear relationship between the dimensionless quantities of porosity and tortuosity is also proposed. (Received September 05, 2012)

1085-60-155 **Partha Sarathi Dey*** (partha@cims.nyu.edu) and **Shirshendu Chatterjee**. *Multiple phase transitions for long-range first-passage percolation on square lattice.*

Given a graph G with non-negative edge weights, the passage time of a path is the sum of weights of the edges in the path, and the first-passage time to reach u from v is the minimum passage time over all paths joining them. We consider a long range first-passage model on Z^d in which, the weight w of the edge joining x and y has an exponential distribution with mean $|x-y|^\alpha$, and the edge weights are independent. We analyze the growth of the set of vertices reachable from the origin within time t, and show that there are four different growth regimes

depending on the value of α. For $\alpha < d$, the growth is instanteneous; for $\alpha \in (d, 2d)$ the growth rate is stretched exponential; for $\alpha \in (2d, 2d+1)$ the growth rate is superlinear and finally for $\alpha > 2d+1$ the growth rate is linear like the standard first-passage percolation model. (Received September 07, 2012)

1085-60-211 **Patricia Goncalves**, **Milton Jara** and **Sunder Sethuraman*** (sethuram@math.arizona.edu). *A stochastic Burgers equation from zero-range interactions.* Preliminary report.

We derive a type of stochastic Burgers equation, formally given by taking the gradient of the KPZ equation, in terms of a martingale problem, as a scaling limit of fluctuation fields in weakly asymmetric zero-range interacting particle systems. (Received September 10, 2012)

1085-60-240 **Thilanka Appuhamillage*** (thilanka@math.hawaii.edu), Department of mathematics, University of hawaii at Manoa, Honolulu, HI 96822, **Vrushali Bokil** (bokilv@math.oregonstate.edu), Department of Mathematics, Oregon State university, Corvallis, OR 97331, **Enrique Thomann** (thomann@math.oregonstate.edu), Department of Mathematics, Oregon State University, Corvallis, OR 97331, **Edward Waymire** (waymire@math.orst.edu), Department of mathematics, Oregon State university, Corvallis, OR 97331, and **Brian Wood** (brian.wood@oregonstate.edu), Chemical, Biological and Environmental Engine, Oregon State University, Corvallis, OR 97331. *Dispersion in spatially fragmented domains with sharp interfaces: the role of the interface condition.*

The presence of sharp interfaces in spatially fragmented domains has an effect on dispersion that are of broad interest in geophysical, ecological and environmental applications. In such environments, modeling dispersion need careful understanding of the relevant biological/physical quantity to capture the correct interface condition. In this talk I will present some examples of different interface conditions from hydrology, ecology and physical oceanography as well as recent related results on effects of sharp interfaces. This talk is based on joint work with Vrushali Bokil, Enrique Thomann, Ed Waymire and Brian Wood. (Received September 10, 2012)

1085-60-281 **Karl E Liechty*** (kliechty@umich.edu), University of Michigan, Department of Mathematics, 530 Church St., Ann Arbor, MI 48109. *Extremal statistics for the Airy$_2$ process minus a parabola.*

The Airy$_2$ process is a stationary process whose marginal distribution is the Tracy-Widom GUE distribution. It was introduced by Prahofer and Spohn in the context of the discrete polynuclear growth model, but is expected to govern the spatial fluctuations in a wide range of physical systems, namely those in the so-called KPZ universality class. I will discuss some recent and some not-so-recent results for the maximum of the Airy$_2$ process minus a parabola and the location of this maximum. These statistics appear in the study of a directed polymer in a random medium. (Received September 11, 2012)

1085-60-283 **Igor Rumanov*** (igor.rumanov@colorado.edu), University of Colorado at Boulder, Department of Mathematics, Boulder, CO 80302. *Hard edge for beta ensembles and Painleve III.*

Starting from the diffusion equation at beta random matrix hard edge obtained by Ramirez and Rider (2008), we study the question of its relation with Lax pairs for Painleve III. The results are in many respects similar to the ones found for soft edge by Bloemendal and Virag (2010). In particular, the values beta = 2 and 4 (but not beta = 1) allow for a simple connection with Painleve III solutions and Lax pairs, however, there is an additional surprise. Besides, our considerations can be extended to the other Painleve equations since the corresponding diffusions are in fact known as quantum Painleve Hamiltonians. (Received September 11, 2012)

62 ► Statistics

1085-62-138 **Nakahiro Yoshida*** (nakahiro@ms.u-tokyo.ac.jp). *Limit theorems in statistics for volatility.*

We consider the stochastic integral equation

$$X_t \quad = \quad X_0 + \int_0^t b_s ds + \int_0^t \sigma_s dw_s, \qquad t \in [0,1]$$

and discuss parametric/non-parametric estimation for the volatility $\sigma_\cdot$ based on the observations $(X_{t_j})_{j=0,1,\dots,n}$, $t_j = j/n$.

The quasi likelihood analysis (QLA) is a systematic analysis of the quasi likelihood random field and the associated estimators (quasi MLE, quasi Bayesian estimators), with a large deviation method that derives precise

tail probability estimates for the random field and estimators. QLA can be obtained for parametric volatility estimation (Uchida and Y. LeMans2009). The QLA estimators are asymptotically mixed normal and have convergence of moments.

The realized volatility (RV) is a non-parametric estimator of the integrated volatility. The asymptotic mixed normality has been studied for RV and various variations. Asymptotic expansion for RV can be obtained from the martingale expansion in asymptotically mixed normal limit. The expansion formula is expressed by the adjoint of a random symbol with coefficients described by the Malliavin calculus.

Asymptotic expansion of the parametric estimators follows from the martingale expansion and QLA. (Received September 06, 2012)

65 ► Numerical analysis

1085-65-11 **Nguyen S Hoang*** (nhoang@math.ou.edu), Department of Mathematics, The University of Oklahoma, Norman, OK 73019. *Dynamical Systems Method (DSM) for solving equations with monotone operators without smoothness assumptions on $F(u)$.*

A version of the Dynamical Systems Method (DSM) for solving ill-posed nonlinear equations $F(u) = f$ with monotone operators F in a Hilbert space is studied in this paper under less restrictive assumptions on the nonlinear operators F than the assumptions used earlier. A new method of proof of the basic results is used. An a posteriori stopping rule, based on a discrepancy-type principle, is proposed and justified mathematically under weaker assumptions on the nonlinear operator F, than the assumptions used earlier. (Received June 04, 2012)

1085-65-34 **Yu-Min Chung*** (yumchung@indiana.edu), Rawles Hall, 831 E. 3rd St., Bloomington, IN 47404, and **M.S. Jolly**. *On the computation of foliations and tracking initial conditions for differential equations.*

The Hartman-Grobman Theorem provides a local foliation for an ODE near a hyperbolic point; through all nearby points there are a pair of leaves that define a conjugacy to the linearized flow. In the classic case one leaf passing through the hyperbolic point is its unstable manifold, the other its stable manifold, both of which are invariant. In general the leaves are not invariant. They can, however, be characterized by the exponential growth/decay rates of the differences between solutions that start on them. If the gap in the spectrum of the linear part sufficiently dominates the Lipschitz condition of the nonlinear part in a large enough neighborhood, and the spectrum is positioned properly, the unstable manifold is an inertial manifold. Each solution is attracted at an exponential rate to a particular "tracking" solution on the inertial manifold. We present several algorithms for the accurate computation of the leaves in the foliation and as well as for the tracking initial condition for a given solution. The algorithms are demonstrated on the Kuramoto-Sivashinsky equation. (Received August 10, 2012)

1085-65-125 **Naoki Saito*** (saito@math.ucdavis.edu), **Yuji Nakatsukasa** and **Ernest Woei**. *Graphs that possess a Laplacian eigenvalue exactly equal to 4.*

It is well known that the eigenvalues of the Laplacian matrix $L(G)$ of a given graph G reflect various geometric and topological information about G. What is lesser known is that for an unweighted tree, the Laplacian eigenvalue $\lambda = 4$ serves as a threshold for the phase transition phenomenon: the eigenvectors of $L(G)$ corresponding to $\lambda < 4$ oscillate *semi-globally* (like Fourier modes) while those for $\lambda > 4$ are *localized* and *concentrated* (like wavelets) around junctions (i.e., branching vertices). In this talk, we will discuss our current understanding on graphs that possess a Laplacian eigenvalue *exactly equal to 4*. In particular, we will discuss two such classes of special trees as well as a class of finite lattice graphs (i.e., the Cartesian product of path graphs) including their interesting behaviors. (Received September 05, 2012)

1085-65-184 **Denis A Silantyev*** (proden09@gmail.com) and **Pavel Lushnikov**. *Reduced model of Vlasov equation and study of it's instabilities in thermodynamic equilibrium.*

Enormous computational difficulties arising in modeling plasma dynamics by solving Vlasov equation directly in 3 spatial dimensions (and 3 velocity dimensions) motivate the search of more practical models of plasma dynamics. Here we consider Vlasov Multi-Dimensional model which is reduction of Vlasov model, that is specifically designed to take advantage of solution properties in regimes when plasma waves are confined to a narrow cone. To understand what additional constrictions this model imposes on the system we study it's instabilities. (Received September 10, 2012)

1085-65-199 **James Hall**, **Melvin Leok*** (mleok@math.ucsd.edu) and **Tatiana Shingel**. *The Construction and Analysis of Variational Integrators.*

We will review the role of Jacobi's solution of the Hamilton–Jacobi equation in the variational error analysis of variational integrators, and demonstrate how it leads to two systematic methods for constructing variational integrators. In particular, Jacobi's solution can be characterized either in terms of a boundary-value problem or variationally, and these lead to shooting-based variational integrators and Galerkin variational integrators, respectively.

Computable discrete Lagrangians can be obtained by choosing a numerical quadrature formula, and either a finite-dimensional function space or an underlying one-step method. We prove that the resulting variational integrator is order-optimal, in that the order of the resulting variational integrator is only limited by the order of accuracy of the numerical quadrature formula, and either the approximation properties of the finite-dimensional function space or the order of accuracy of the underlying one-step method.

We will also discuss generalizations of variational integrators to Lie groups and homogeneous spaces. Time permitting, we will also describe efforts to generalize the error analysis to the setting of Lagrangian PDEs. (Received September 10, 2012)

1085-65-201 **Daniel Erik, Axel Appelo***, appelo@math.unm.edu, and **Thomas Hagstrom**. *Simulation of compressible turbulence using Hermite Methods.*

Hermite methods are general-purpose polynomial-based spectral elements whose unique properties make them ideal for the efficient exploitation of massively-parallel modern multicore processors, exhibiting the following features

I.: High-resolution enabling a minimal number of degrees-of-freedom per wavelength;

II.: Large computation-to-communication ratio to efficiently use multicore nodes and local memory.

In this talk we describe the basic elements of Hermite methods and present some results from their application to the simulation of some turbulent compressible flows. (Received September 10, 2012)

1085-65-216 **Pedro R S Antunes***, Inst. Investigação Interdisciplinar, Av. Prof. Gama Pinto, 2, 1649-003, Lisbon, Portugal. *Numerical optimization of eigenvalues using the Method of Fundamental Solutions.*

In this talk we consider some shape optimization problems for eigenvalues of the Laplacian. The solution of these problems has been studied by using several numerical methods. We address the use of a gradient type method with the Method of Fundamental Solutions as forward solver. Several examples are presented to illustrate the good performance of the method. (Received September 10, 2012)

74 ► Mechanics of deformable solids

1085-74-46 **Francois Gay-Balmaz** (gaybalma@lmd.ens.fr), LMD - Ecole Normale Superieure de Paris, 75005 Paris, France, and **Vakhtang Putkaradze*** (putkarad@ualberta.ca), Department of Mathematics and Statistics, University of Alberta, CAB 632, Edmonton, Alberta T6G 2G1, Canada. *Dynamics of elastic rods in perfect friction contact.*

One of the most challenging and basic problems in elastic rod dynamics is a description of rods in contact that prevents any unphysical self-intersections. Most previous works addressed this issue through the introduction of short-range potentials. We study the dynamics of elastic rods with perfect rolling contact which is physically relevant for rods with rough surface. Such dynamics cannot be described by the introduction of any kind of potential. We show that, surprisingly, the presence of rolling contact in rod dynamics leads to highly complex rod dynamics, even for small rod deformations. (Received August 20, 2012)

1085-74-47 **Michael Tabor*** (tabor@math.arizona.edu), Program in Applied Mathematics, University of Arizona, Tucson, AZ 85721-0089. *Perversion in Phycomyces: theoretical models and experimental results.*

The filamentary fungus *Phycomyces blakesleeanus* undergoes a series of remarkable transitions during aerial growth. During the so-called Stage IV growth phase, the fungus extends while rotating in a counterclockwise manner (Stage IVa) and then, while continuing to grow, spontaneously reverses to a clockwise rotation (Stage IVb). This phase lasts for 24 - 48 hours and is sometimes followed by yet another reversal (Stage IVc) before the overall growth ends. We describe a continuum mechanical model, including growth, of the entire process using nonlinear, anisotropic, elasticity and show how helical anisotropy associated with the cell wall structure can induce spontaneous rotation and, under appropriate circumstances, the observed reversal of rotational handedness.

Recent experiments involving high-resolution time-lapse photography clearly demonstrate the dynamics of the growth and rotation. Spontaneous reversal of rotation is an example of *perversion* and the spontaneous reversal in expansion and/or extension (of a tube) is an example of *inversion*. Motivated by the work on Phycomyces a general formalism for studying perversions and inversions in thin-walled elastic tubes is described. (Received August 20, 2012)

1085-74-236 **Shankar C Venkataramani*** (shankar@math.arizona.edu), Department of Mathematics, 617 N. Santa Rita Ave., University of Arizona, Tucson, AZ 85721, and **John A Gemmer**. *Geometry and Elasticity for Non-Euclidean thin sheets.* Preliminary report.

Soft matter is defined by its ability to deform strongly in response to applied forces. These forces can be external or can arise spontaneously as a result the intrinsic geometry of the material.

A prototypical example of a soft material is a Non-Euclidean thin sheet, that is a thin elastic object whose intrinsic geometry is not flat, and hence has non zero internal stresses arising as a result of being embedded in flat $\mathbb{R}^3$. The response of the sheet to this geometric frustration plays a key role, for example, in determining the structure of leaves and flowers.

A fundamental question is whether we can deduce the three dimensional conformation of a non Euclidean sheet, given the knowledge of its geometry. I will present some mathematical results about this question, and then discuss some of the physical implications for these mathematical results. (Received September 10, 2012)

76 ► Fluid mechanics

1085-76-44 **Lidia Bloshanskaya***, Box 41042, Lubbock, TX 79409 -104, **Eugenio Aulisa** (eugino.aulisa@ttu.edu), Box 41042, Lubbock, TX, Lubbock, TX 79409-1042, **Yalchin Efendiev** (efendiev@math.tamu.edu), Department of Mathematics, Texas A&M Universi, College Station, TX 79409, and **Akif Ibragimov** (akif.ibraguimov@ttu.edu), , Box 41042, Luubock, TX 79409-1042. *Up-scaling method for Forchheimer flow of the compressible and incompressible fluid in heterogeneous porous media.*

Non-linear two term Forchheimer law is considered for incompressible and slightly compressible fluid filtration in the heterogeneous porous media. The aim is to replace the permeability tensors on a fine scale with an equivalent permeability tensor on a coarse scale. For compressible fluids even for Darcy case corresponding equation is evolutional one, and therefore usually ups-scaled parameters obtained for steady state used in the homogenization algorithm. For time dependent problem (slightly compressible fluid) we establish an alternative approach of up-scaling by introducing pseudo-steady state (PSS) solution, which is time invariant with respect to so called diffusive capacity. PSS solution is split in time and space dependent functions. Spatial function satisfies equation with RHS depending on inhomogeneous porosity. This approach justified, because time depended diffusive capacity converges to steady state one exponentially. For both steady state and pseudo-steady state problem a flow-based coarsening approach is used, where the equivalent permeability tensor and porosity is first evaluated following the streamline of the existing linear cases, and successively modified in order to take into account the non-linear effects. (Received August 19, 2012)

1085-76-66 **Bjorn Birnir*** (birnir@math.ucsb.edu), Dept. of Math, Univ. of California, Santa Barbara, Santa Barbara, CA 93117. *The Statistical Theory of Turbulent Vorticity.*

In this talk we show how to construct the invariant measure of the turbulent vorticity field from the stochastic Navier-Stokes equations for the vorticity. Projecting the measure onto the probability density function (PDF) for the vorticity allows us to compute all the moments of the turbulent vorticity. The invariant measure is a product of an infinite Gaussian measure with a Poisson measure generating the intermittency in turbulence. This implies that each moment comes with its own PDF. We show that all of these PDFs are normal inverse (NIG) distributions of Barndorff-Nilsen and compare the theoretical PDFs with PDFs from simulations. (Received August 29, 2012)

1085-76-82 **Alexander M Balk*** (balk@math.utah.edu), 155 S 1400 E Rm 233, Department of Mathematics, University of Utah, Salt Lake City, UT 84103. *Extra Invariant: From Shallow Water to 3D Oceans.*

The 3-dimensional fluid dynamics under rapid rotation with beta-effect is shown to possess an extra invariant; its presence leading to anisotropic inverse cascade of energy towards zonal jets.

The dynamics is described by the incompressible Euler equation with Coriolis force

$$\mathbf{v}_t + (\mathbf{v}\cdot\nabla)\mathbf{v} + \mathbf{f}\times\mathbf{v} \quad = -\nabla\Pi, \qquad \nabla\cdot\mathbf{v} \quad = 0;$$

$\mathbf{f} = (f_0 + \beta y)\hat{\mathbf{z}}$ slowly depends on the longitudinal coordinate y.

The invariant is

$$I = \frac{1}{2}\int X_{\mathbf{k}}\,|\zeta_{\mathbf{k}}(t)|^2\,d\mathbf{k},$$

where $\mathbf{k} = (p, q)$ is the horizontal wave vector, and $\zeta_{\mathbf{k}}(t)$ is the Fourier transform of the vertically averaged vorticity

$$\zeta(x, y, t) = \frac{1}{H}\int_0^H (v_x - u_y)dz$$

(H is the depth of the fluid layer); the kernel is

$$X_{\mathbf{k}} = \frac{p^2(p^2 + 5q^2)}{k^{10}}.$$

(Received August 31, 2012)

1085-76-108 **Jerry Bona*** (bona@math.uic.edu), Dept. Math. Statistics & Computer Science, University of Illinois at Chicago, 851 S. Morgan St. MC 249, Chicago, IL 60607. *Propagation of Long-crested Water Waves.* Preliminary report.

Long-crested wave motion is often seen in the deep ocean, in near-shore zones and on rivers and estuaries. In the 19th century, it was common to use one-dimensional models to describe such motions. However, there are situations which are still considered long-crested where variations along the crest are significant enough to warrant more refined modeling. The lecture will report on some recent progress on long-crested wave propagation with especial attention paid to the lateral boundary conditions. (Received September 04, 2012)

1085-76-126 **Susan Friedlander*** (susanfri@usc.edu), USC Dept of Math, 3620 S. Vermont Ave, Los Angeles, CA 90089. *The Importance Of Being Even.*

We discuss several nonlinear active scalar equations that arise in fluid dynamics. These include the surface quasigeostrophic equation and modified versions, the magnetogeostrophic equation, the incompressible porous media equation and modified versions. We pay particular attention to the situation where the divergence free drift velocity is more singular than the active scalar. We discuss results for both the non-diffusive equations and the fractionally diffusive equations. We show that when the operator that encodes the constitutive law is even rather than odd, the equations with regular initial data can be Lipschitz ill-posed.

This is joint work with Vlad Vicol, Walter Rusin, Francisco Gancedo and Weiran Sun. (Received September 05, 2012)

1085-76-140 **Jean-Claude Saut**, Bat. 425, 91405 Orsay, France, **Roger Temam**, Rawles Hall, Bloomington, IN 47405-5701, and **Chuntian Wang*** (wang211@umail.iu.edu), Rawles Hall, 831 East 3rd St, Bloomington, IN 47405. *An initial and boundary-value problem for the Zakharov-Kuznestov equation in a bounded domain.*

Motivated by the study of boundary control problems for the Zakharov-Kuznetsov equation, we study in this article the initial and boundary value problem for the ZK equation posed in a limited domain $\Omega = (0, 1)_x \times (-\pi/2, \pi/2)^d$, $d = 1, 2$. This article is related to the previous work (Jean- Claude Saut and Roger Temam, *An Initial boundary-value problem for the Zakharov-Kuznetsov equation*", Adv. Differential Euqations 15 (2010), no. 11-12, 1001-1031. MR 2743493), in which the authors studied the same problem in the band $(0, 1)_x \times \mathbb{R}^d$, $d = 1, 2$, but this article is not a straightforward adaptation of the previous work; indeed many new issues arise, in particular for the function spaces, due to the loss of the Fourier transform in the tangential directions (orthogonal to $0x$).

In this article, after studying a number of suitable function spaces, we show the existence and uniqueness of solutions for the linearized equation using the linear semigroup theory. We then continue with the nonlinear equation with the homogeneous boundary conditions. The case of the full nonlinear equation with nonhomogeneous boundary conditions especially needed for the control problems will be studied elsewhere. (Received September 06, 2012)

1085-76-176 **Alexander O. Korotkevich***, MSC01 1115, 1 University of New Mexico, Albuquerque, NM 87131-0001. *Numerical simulation of inverse cascade of water gravity waves in the presence of condensate.*

Numerical experiment with a goal of observation of inverse cascade of surface gravity waves was performed in the framework of primordial dynamical equations. Kolmogorov- like spectrum was generated. The slope of the

spectrum differs significantly from the one predicted by the weak turbulence theory. In this work we discuss both the obtained results and possible causes of this deviation from the theory. We believe that the results is due to the influence of the condensate which forms in the region of small wavenumbers. As it was shown before (Korotkevich 2008, 2012) such condensate is changing the direct cascade slope. Although, in the case of inverse cascade the mechanism of its influence, probably, is completely different. (Received September 09, 2012)

1085-76-197 **Joseph J Tribbia*** (tribbia@ucar.edu), 1850 Table Mesa Drive, Boulder, CO 80305. *New developments in geostrophic turbulence and its implications for climate modeling and weather predictability.*

One of the many areas in geophysical fluid dynamics that impacts how we model dissipation in the climate system is the theory of two-dimensional and quasi geostrophic turbulence and its impact on atmospheric flow. Upscale energy and and down scale enstrophy cascades have been observed in the atmosphere along with the -3 power law predicted in two-dimensional turbulence theory put forward by Batchelor and Kraichnan in the late 1960s. A consequence of this observational finding is the fact that, unlike three-dimensional turbulence in which the eddy turnover time decreases with eddy length scale, in two dimensional and quasi-geostrophic turbulence the eddy turnover time is constant independent of eddy length scale in the enstrophy cascading range. A further consequence of this is that the Rossby number is constant through the enstrophy cascade. This implies that instabilities which depend on ageostrophic processes are restricted because the scaling laws which imply balanced, quasi-geostrophic dynamics are valid at all length scales. Recent results show, however, even given that all of the above statements are true and maintained in the dynamics, there is a mechanism through which quasi-geostrophic turbulence becomes inconsistent. (Received September 10, 2012)

1085-76-202 **Mohamed Moustaoui***, School of Mathematical and Statistical Scienc, tempe, AZ 85287. *Nonlinear wave-wave and vortex interactions and impact on Lagrangian transport of Chemicals in the atmosphere.*

Multi-nested high resolution simulations for real environmental conditions that integrate computational models of disparate scales show that observed distributions of chemicals in the atmosphere can be modulated by nonlinear dynamical processes induced by interactions between waves with different scales evolving on top of a background state that is perturbed by vortex dynamics. A wave with a large wavelength evolving on this perturbed state causes horizontal variations in the mean gradients. Short waves evolving in these perturbed gradients induce wave signatures in chemicals, with amplitudes and phase relationships that depend on the vertical gradients encountered. The proposed mechanism is confirmed by Lagrangian reconstruction of observed tracer variations deduced under this dynamical process. This is further supported by analytical mathematical calculations that use background mean profiles from the observations, where the tracer variations induced by mutual wave-wave interaction are investigated. (Received September 10, 2012)

1085-76-213 **N. Balci*** (nubalci@math.arizona.edu), Dept of Mathematics, U of Arizona, 617 N. Santa Rita Ave., Tucson, AZ 85721, **C. Foias** (foias@math.tamu.edu), Dept of Mathematics, Texas A&M University, Mailstop 3368, College Station, TX 77843, and **M. S. Jolly** (msjolly@indiana.edu), Rawles Hall, 831 E 3rd St, Bloomington, IN 47405. *On Turbulence and Heat Convection.*

We discuss the application of the 2-D turbulence theory to the 3D Rayleigh-Benard problem. We estimate the force and derive the analogs of the theorems for 2-D general force case in this setting. Joint work with C. Foias and M. Jolly. (Received September 10, 2012)

1085-76-223 **Wenbo Tang*** (wenbo.tang@asu.edu), PSA837, School of Mathematical & Statistical Sciences, Arizona State University, Tempe, AZ 85296, and **PW Chan** and **George Haller**. *Advances in airflow hazard detection at the Hong Kong International Airport.*

In recent years, characterization of flow coherent structures via dynamical systems methods has been popularized by the development of extracting finite-time invariant manifolds in aperiodic flow data. In this talk, I will discuss the series of developments around conforming the mathematical tools to detect air flow hazards at the Hong Kong International Airport. (Received September 10, 2012)

1085-76-228 **Charles R. Doering*** (doering@umich.edu), Departments of Mathematics and Physics, and Center for the Study of Complex Systems, University of Michigan, Ann Arbor, MI 48109-1043. *Ultimate state of two-dimensional Rayleigh-Bénard convection.*

Rayleigh-Bénard convection is the buoyancy-driven flow of a fluid heated from below and cooled from above. Heat transport by convection an important physical process for applications in engineering, atmosphere and ocean science, and astrophysics, and it serves as a fundamental paradigm of modern nonlinear dynamics, pattern

formation, chaos, and turbulence theory. Determining the transport properties of high Rayleigh number convection turbulent convection remains a challenge for experiment, simulation, theory, and analysis. In this talk, after a brief survey of the theory and applications of thermal convection we describe recent results for rigorous upper limits on the vertical heat transport in two dimensions between stress-free isothermal boundaries derived from the Boussinesq approximation of the Navier-Stokes equations (Rayleigh's original model). These bounds on the heat transport scaling challenge one popular theoretical argument for asymptotic high Rayleigh number convection. This is joint work with Jared Whitehead. (Received September 10, 2012)

1085-76-231 **Mihaela Ignatova**, **Gautam Iyer**, **James P Kelliher*** (kelliher@math.ucr.edu), **Robert L Pego** and **Arghir D Zarnescu**. *Some recent results for two extended Navier-Stokes systems.*

We discuss recent results on the well-posedness of two extended Navier-Stokes equations. These results build on the earlier works of Liu, Liu, and Pego and Pego, Iyer, and Zarnescu. (Received September 10, 2012)

1085-76-274 **Andrey A. Gelash*** (gelash@srd.nsu.ru), Novosibirsk State University, 630090 Novosibirsk, Russian Federation, and **Vladimir E. Zakharov** (zakharov@math.arizona.edu), University of Arizona, 857201 Tucson, AZ, USA. *On nonlinear stage of the modulational instability.*

There is a point of common agreement that freak (or rogue) waves appear as a result of modulational instability of quasimonochromatic nonlinear waves. In terms of the Nonlinear Schrödinger Equation (NLSE) model we should study instability of the "condensate" in the focusing version of this equation. In this work we study only solitonic solutions of NLSE. By the use of "dressing method" we obtain explicit expressions for general one and two-solitonic solutions. General n-solitonic solution we obtain in the form of the ratio of two determinants. These solutions are not new; however, their properties have not been studied carefully. Among wide family of solutions we separate a special class of "regular solitonic solutions" which localized in space and have equal phases at $x \to \pm\infty$. If we assume that the modulational instability develops from localized perturbation, only regular solution can be used as model for its nonlinear behavior. We show criterion that n-solitonic solution is regular. The central point of our work is a description of a class of regular solution which is a small perturbation at initial moment of time. This allows us to describe the development of the nonlinear stage of modulation instability. (Received September 11, 2012)

1085-76-275 **Adam Larios*** (alarios@math.tamu.edu), Dept. of Mathematics, Texas A&M University, Mail Stop 3368, College Station, TX 77843-3, and **Evelyn Lunasin** and **Edriss S Titi**. *Regularizations for Fluid Models with Applications to Geophysical Flows.*

Recently, the Voigt-regularization, which is related to the alpha-models of turbulent flows, has been investigated as a regularization of various fluid models. It overcomes many of the problems present in other alpha-models; for example, it is well-posed in bounded domains, and, in periodic domains, it is globally well-posed even in the case of zero viscosity. Moreover, in studying the limit as the regularization parameter tends to zero, a new criterion for the finite-time blow-up of the original equations arises. I will discuss recent analytical and numerical work on the Voigt-regularization for the Navier-Stokes equations for fluid flows, and Boussinesq Equations equations for ocean flows. Time permitting, I will also discuss a new regularization called the entropy viscosity model. (Received September 11, 2012)

78 ► Optics, electromagnetic theory

1085-78-59 **Thomas D Trogdon*** (trogdon@amath.washington.edu), University of Washington, Department of Applied Mathematics, Guggenheim Hall #404, Box 352420, Seattle, WA 98195-2420. *Instabilities of the hyperbolic (2+1)-dimensional NLS equation: Water waves to nonlinear optics.*

The hyperbolic (2+1)-dimensional Nonlinear Schrödinger equation describes both deep water waves and spatial optical solitons in dispersive media. Previous results indicated that low-dimensional solitons are stable to transverse perturbations with sufficiently large wave numbers. The work of Deconinck, Pelinovsky and Carter showed the opposite. Transverse perturbations always introduce an instability. The gain of this instability, the so-called oscillatory snake instability, is too small to be seen in water wave experiments. In this talk I will discuss the experimental demonstration of the oscillatory snake instability for laser beams propagating in dispersive media. (Received August 27, 2012)

1085-78-147 **Ben Cox*** (b.cox@ucl.ac.uk), **Teedah Saratoon**, **Tanja Tarvainen** and **Simon R. Arridge**. *Quantitative Photoacoustic Imaging using the Radiative Transfer Equation.*

Photoacoustic imaging involves two sequential inverse problems: an acoustic inversion followed by an optical one. The acoustic inversion is a well-posed inverse initial value problem that has largely been solved. The results are beginning to be used widely in biomedical imaging applications but the images are only qualitative. Photoacoustic imaging would become much more powerful if it were possible to obtain quantitative chemically specific images, but for this it is necessary to solve the optical inversion. This is ill-posed due to the diffusive nature of light propagation in turbid media, and while progress has been made in recent years the results have yet to be successfully translated into the laboratory. The constraints on the inversion will be discussed, and recent progress towards a solution using a gradient-based inversion of the radiative transfer equation will be described. (Received September 07, 2012)

1085-78-161 **Mark A. Anastasio*** (anastasio@wustl.edu), Washington University in St. Louis, Department of Biomedical Engineering, St. Louis, MO 63130, and **Chao Huang** and **Lihong V. Wang**. *Photoacoustic Tomography Image Reconstruction in Heterogeneous Acoustic Media with Incomplete Data.*

Photoacoustic tomography (PAT) is an emerging soft-tissue imaging modality that has great potential for a wide range of biomedical imaging applications. It can be viewed as a hybrid imaging modality in the sense that it utilizes an optical contrast mechanism combined with ultrasonic detection principles, thereby combining the advantages of optical and ultrasonic imaging while circumventing their primary limitations. The goal of PAT is to reconstruct the distribution of an object's absorbed optical energy density from measurements of pressure wavefields that are induced via the thermoacoustic effect. In this talk, we review our recent advancements in practical image reconstruction approaches for PAT in heterogeneous acoustic media. Such advancements include physics-based models of the measurement process and associated inversion methods for reconstructing images from limited data sets. Applications of PAT to transcranial brain imaging are presented. (Received September 07, 2012)

1085-78-172 **T. M. Dunster*** (dunster@math.sdsu.edu), Department of Mathematics and Statistics, San Diego State University, 5500 Campanile Drive, San Diego, CA 92182-7720. *Electromagnetic wave scattering from two infinite dielectric cylinders.*

We consider wave scattering from 2 parallel infinite dielectric cylinders, illuminated by an incident electric field with arbitrary distribution and polarization. The scattered electric and magnetic fields from both cylinders can be expressed as infinite series involving Hankel functions, and whose coefficients satisfy a coupled system (which involve Bessel and Hankel functions). We show how this system can be simply decoupled, and this in turn solved by successive approximations. We finally rigorously prove, under explicit conditions on the physical parameters of the problem, convergence of the successive approximation scheme. This is achieved by utilizing certain bounds on Bessel functions, which are derived from asymptotic and integral representations. (Received September 09, 2012)

1085-78-177 **Natalia Vladimirova*** (nvladimi@unm.edu), Department of Mathematics and Statistics, MSC01 1115, 1 University of New Mexico, Albuquerque, NM 87131, and **Gregory Falkovich** (gregory.falkovich@weizmann.ac.il), Department of Physics of Complex Systems, Faculty of Physics, Weizmann Institute of Science, 76100 Rehovot, Israel. *Phase transitions in optical turbulence.*

We consider turbulence in the Gross-Pitaevsky model and study the creation of a coherent condensate via an inverse cascade originated at small scales. The growth of the condensate leads to a spontaneous breakdown of symmetries of small-scale over-condensate fluctuations: first, statistical isotropy is broken, then series of phase transitions mark the change of symmetry from the two-fold to three-fold to four-fold. We describe respective anisotropic spectral flux flows in k-space. At the highest condensate level reached, we observe a short-range positional and long-range orientational order (like in a hexatic phase). In other words, the longer one pumps the system the more ordered it becomes. The phase transitions happen when the driving term corresponds to an instability and does not occur when pumped by a random force. We thus demonstrate for the first time non-universality of an inverse-cascade turbulence with respect to the nature of small-scale forcing. (Received September 10, 2012)

1085-78-178 **Pavel M Lushnikov***, Department of Mathematics and Statistics, MSC01 1115, 1 University of New Mexico, Albuquerque, NM 87131-0001, and **Sergey A Dyachenko** and **Natalia Vladimirova**. *Beyond log-log scaling of critical collapse of Nonlinear Schrodinger equation.*

We study the collapse of the nonlinear Schrodinger equation (NLS) in critical case of dimension two. The collapse describes e.g. self-focusing of light in nonlinear Kerr media. The scaling of self-similar solutions near collapse point has $(t_0-t)^{1/2}$ scaling law with the logarithmic modifications of log-log type. We show that the well-known leading order log-log modification occurs for nonrealistic exponentially large amplitudes of light $\sim 10^{10^{100}}$. Instead we derived a new equation for adiabatically slow parameter which determines the system dynamics. Based on that equation we develop a perturbation theory for scaling modifications beyond leading log-log order and perform detailed comparison with simulations. We show that new scaling agrees with simulations for very moderate increase (~ 3 times) of the amplitude of initial pulse. (Received September 10, 2012)

1085-78-187 **Jinjie Liu*** (jliu@desu.edu), Delaware State University, Dover, DE 19901, **Moysey Brio**, The University of Arizona, Tucson, AZ 85721, and **Jerome V Moloney**, The University of Arizona, Tucson, AZ 85721. *Stable FDTD Methods for Material Interfaces.*

In the Finite-Difference Time-Domain (FDTD) simulations for solving Maxwell's equations of electrodynamics, material interfaces sometimes cause instability. In this work, we focus on overcoming some of these instability problems. First, for material interfaces between anisotropic dielectrics and dispersive medium or perfectly electric conductor (PEC), we propose an anisotropic Overlapping Yee FDTD algorithm. The previous proposed conventional anisotropic FDTD methods suffer from the late-time instability due to the extrapolation near the material interface. Our method relies on the overlapping cells to provide the collocated field values without any interpolation or extrapolation, so the instability due to extrapolation is avoided. Second, for interface between dispersive and dielectric materials, we propose a new subpixel smoothing FDTD algorithm by using a local coordinate rotation approach. Our approach does not require field splitting so better efficiency is achieved in comparison to the previous proposed algorithm. (Received September 10, 2012)

1085-78-206 **Frank W Wise*** (frank.wise@cornell.edu), Department of Applied Physics, Cornell University, Ithaca, NY 14850, **Nathan Kutz** (kutz@amath.washington.edu), Department of Applied Mathematics, University of Washington, Seattle, WA , and **William Renninger**, Department of Applied Physics, Cornell University, Ithaca, NY 14850. *High-Performance Femtosecond Fiber Lasers Based on Dissipative Processes.*

The femtosecond lasers that underlie ultrafast science and technology are based on solitons — pulses that balance anomalous dispersion and nonlinearity. Solitons offer attractive features, but their energy is limited, and this limitation is particularly challenging in fiber lasers. As a consequence, short-pulse fiber lasers have not been competitive with solid-state lasers. Recently, a new class of pulses that form with only normal dispersion has been identified. These are referred to as dissipative solitons. Short-pulse fiber lasers based on them generate pulses with 10-100 times the energy of prior fiber lasers, and much-higher energies may be possible. Theoretical and experimental results on dissipative-soliton lasers will be presented. Important discrepancies between numerical simulations and experimental results will be highlighted. (Received September 10, 2012)

1085-78-219 **Brian D. Hong***, bdhong@email.arizona.edu. *Gain Optimization of the Active Resonant Subcavity in Optically Pumped VECSELs.* Preliminary report.

A simple algorithm for gain optimization in Vertical External-Cavity Surface-Emitting Lasers (VECSELs) is presented. Transfer Matrix and 1D FDTD methods are utilized for electromagnetic wave propagation. Gain is implemented using a complex relative permittivity and optimized at a single wavelength using a genetic algorithm. A substantial increase in single wavelength gain with limited sensitivity to perturbations is obtained through the optimization. From the results it is clear that a more intricate gain model is required, and to this end a more sophisticated saturable gain model is presented to be used in future optimizations. (Received September 10, 2012)

1085-78-241 **Alejandro B Aceves*** (aaceves@smu.edu), Clements Hall 221, Southern Methodist University, Dallas, TX 75275. *"New trends in nonlinear photonics: From binary waveguide arrays to novel PT-symmetric optical systems".*

Photonics in an area of theoretical and applied research that continues to advance rapidly due to technological advances and the use of novel materials such as graphene. In this talk I will present modeling that emerges in two types of photonic systems currently investigated: plasmonic arrays and P(arity)T(ime) photonic devices. In both instances the nonlinear governing equations present new and sometimes unexpected behavior that requires further analysis to go in parallel with ongoing applications (Received September 10, 2012)

1085-78-263 **Evgenii Narimanov*** (evgenii@purdue.edu), Purdue University, School of Electrical and Computer Engineering, West Lafayette, IN 47906. *Wave Propagation and Related Phenomena in Hyperbolic Metamaterials.*

Metamaterials with hyperbolic dispersion (where two eigenvalues of the dielectric permittivity tensor have opposite signs) exhibit a broad bandwidth singularity in the photonic density of states, with resulting manifestations in a variety of phenomena, from spontaneous emission to light propagation and scattering. In particular, waves in such "electromagnetic hyperspace" do not suffer from the diffraction broadening, dramatically changing pulse propagation and focusing in these media. (Received September 11, 2012)

1085-78-273 **Steven T Cundiff*** (cundiff@jila.coloraod.edu), JILA, Univ. Colorado and NIST, 440 UCB, Boulder, CO 80309-0440. *Ultrafast Pulse Propagation Experiments in Waveguide Arrays.*

Light propagation in waveguide arrays initially attracted attention due to the formation of discrete spatial solitons. However there are also interesting temporal dynamics. I will present our experimental work over the last few years on pulse propagation in waveguide arrays, along with extensive comparisons to modeling. Our initial work showed that ultrafast pulses undergo shortening during propagation through a waveguide array. The shortening occurs because the wings couple into neighboring waveguides, whereas the central part of the pulse remains in the launch waveguide. This result showed that waveguide arrays can act as effective saturable absorber. Subsequent studies of the chirp showed that the output pulses from the waveguide array all had the same chirp, if the propagation occurred in the nonlinear regime. This behavior is evidence for a fixed-point attractor in the (intensity,chirp) plane. Observations of the spatial distribution in the waveguide showed that it clamped due to an interplay between three-photon absorption and discrete soliton formation. Finally, preliminary results provide evidence that waveguide arrays can be used as a mode-locking element in a fiber laser. (Received September 11, 2012)

81 ► Quantum theory

1085-81-15 **Gregory Eskin*** (eskin@math.ucla.edu), Department of Mathematics, UCLA, Los Angeles, CA 90095-1555. *The Aharonov-Bohm effect revisited.*

We give a new mathematical proof of the magnetic Aharonov-Bohm effect without using the scattering theory and the theory of inverse boundary value problems. We consider separately the cases of one and several obstacles. The electric and combined electromagnetic AB effects were studied much less. We give the first mathematical proof of the electric AB effect in domains with moving boundaries. When the boundary does not move with the time the electric AB effect is absent. Next we prove the combined electromagnetic AB effect when both magnetic and electric potentials are time-dependent. Finally, we study the gravitational AB effect. (Received June 27, 2012)

1085-81-25 **Nicholas Crawford**, **Stephen Ng** and **Shannon Starr*** (slstarr@uab.edu), UAB Department of Mathematics, Campbell Hall, 1300 University Blvd, Birmingham, AL 35294. *Rigorous Bounds for the EFP.*

Stochastic geometric representations are useful for understanding quantum spin systems. The Trotter product formula is commonly used, and an advanced method is the Aizenman-Nachtergaele representation. We use this and reflection positivity to get rigorous bounds on the emptiness formation probability: the probability to find all spins aligned in a box of side length L in the ground state or Gibbs state of the quantum antiferromagnet. (Received July 18, 2012)

1085-81-75 **Alexander Elgart*** (aelgart@vt.edu), **Mira Shamis** and **Sasha Sodin**. *Localization for non-monotone discrete Schrodinger operators.*

We study a class of random Schrodinger operators with sign-indefinite potentials, in the strong disorder regime.

We prove regularity of the density of states and Anderson localization using a modification of the Aizenman-Molchanov fractional moment method. A particular example of the class of systems covered by our results is the discrete alloy-type Anderson model. (Received August 30, 2012)

1085-81-100 **Christoph A Marx*** (cmarx@caltech.edu), Department of Mathematics, California Institute of Technology, Pasadena, CA 91125, and **Svetlana Jitomirskaya**. *Absence of point spectrum in the self-dual regime for Extended Harper's model.*

Extended Harper's model was introduced by D.J. Thouless to describe a Bloch electron in a 2d crystal layer, general enough to interpolate between a variety of lattice geometries, from rectangular to triangular. Its Hamiltonian can be presented as a 1d quasi-periodic Jacobi operator, where both the sampling functions generating diagonal and off-diagonal matrix elements are trigonometric polynomials of degree 1.

As opposed to the almost Mathieu operator, the model possesses a vast self-dual regime in the space of coupling constants which shows both sub-critical and critical behavior within Avila's "global theory".

In this talk, we present a strategy to prove absence of point spectrum in the self-dual regime. This shows that the self-dual regime is either purely absolutely- or purely singular continuous, governed by the symmetry of the next-nearest coupling terms. The work is joint with Svetlana Jitomirskaya. (Received September 03, 2012)

1085-81-134 **Sven Bachmann*** (svenbac@math.ucdavis.edu), Dept of Mathematics, University of California, Davis, One Shields Ave, Davis, CA 95616, and **Wojciech De Roeck** and **Maximilian Butz**. *On the diffusive regime of disordered quantum wires.*

If the length of a disordered metallic wire is shorter than its localization length, currents can flow. This regime is most conveniently studied in a weak coupling limit, where the strength of the disorder vanishes as the wire's length increases. In this talk, I will describe the transport properties of such a quantum wire through its transfer matrix. As a function of the wire's length, it satisfies a stochastic differential equation, which implies in particular Ohm's law for the conductance in the appropriate thick wire limit. (Received September 06, 2012)

1085-81-159 **A. Pizzo*** (pizzo@math.ucdavis.edu) and **D. A. Deckert** (deckert@math.ucdavis.edu). *Ultraviolet properties of the spinless, one-particle Yukawa model.*

We consider the one-particle sector of the spinless Yukawa model, which describes the interaction of a nucleon with a real field of scalar massive bosons (neutral mesons). The nucleon as well as the mesons have relativistic dispersion relations. In this model we study the dependence of the nucleon mass shell on the ultraviolet cut-off Λ. For any finite ultraviolet cut-off the nucleon one-particle states are constructed in a bounded region of the energy-momentum space. We identify the dependence of the ground state energy on Λ and the coupling constant. More importantly, we show that the model considered here becomes essentially trivial in the limit $\Lambda \to \infty$ regardless of any (nucleon) mass and self-energy renormalization. Our results hold in the small coupling regime. This is a joint work with D.-A. Deckert. (Received September 07, 2012)

1085-81-173 **Jeremy Thane Clark*** (jtclark@msu.math.edu). *Diffusive limit for a quantum linear Boltzmann dynamics.*

I will discuss a quantum linear Boltzmann dynamics proposed by Bassano Vacchini and Klaus Hornberger, which models a test particle receiving collisions from a background gas. The state of the particle is represented by a density matrix whose time evolution is determined by a translation-covariant Lindblad equation. My mathematical results for this model concern the characterization of its diffusive behavior in the specific case for which the gas particle scattering occurs through a hard-sphere interaction. (Received September 09, 2012)

1085-81-195 **Michael A Bishop*** (mbishop@math.arizona.edu). *Ground State of Interacting Boson Systems in Random Potentials.*

The recent experimental realization of Bose-Einstein condensate and the development of techniques in cold atom experiments provide new methods for investigating quantum phenomena and the models that describe them. The Gross-Pitaevskii mean-field approximation is a popular model for describing these interacting boson systems. In this approximation, each particle in the many-particle state is assumed to have the same one-particle state, substituting a linear operator on a large tensor space with a nonlinear operator on a smaller function space. I will discuss a work in preparation with J. Wehr on the ground state of Gross-Pitaevskii mean-field model with local 'soft core' interactions and random potentials. The interplay of interactions and random potentials is unclear: particles localize in systems with random potentials, but repulsive interactions cause states to spread because localization of the entire multi-particle state is energetically expensive. The main result is a criterion for the minimal localization of a mean-field state given its per particle energy and the interaction strength. To help understand this theorem, it will be applied to the model in one discrete dimension with Bernoulli distributed potential. (Received September 10, 2012)

1085-81-267 **Jeffrey Schenker*** (jeffrey@math.msu.edu), **Bernard Clark Musselman**, **Yang Kang** and **Eman Hamza**. *Diffusion of waves in fluctuating media.*

I will discuss recent work on diffusive scaling and diffusion for solutions to the tight binding Schroedinger equation with time dependent randomness. (Received September 11, 2012)

1085-81-294 **Helge Krueger*** (helge@caltech.edu), MC 253-37, Pasadena, CA 91125. *Skew Shift Schroedinger Operators.*

I will discuss recent developments in skew-shift Schroedinger operators. (Received September 12, 2012)

82 ► Statistical mechanics, structure of matter

1085-82-86 **Jacob W Chapman*** (jchapman@uab.edu), 1720 2nd Avenue South, Birmingham, AL 35294, and **Günter Stolz**. *Localization for a Non-Monotone Random Block Operator.* Preliminary report.

A non-monotone random block operator arising from quantum spin systems will be introduced. The recent work of Elgart, Shamis, and Sodin, making use of the fractional moment method, implies dynamical localization for this operator, but only at large disorder. Being closely connected to the 1D Anderson model, this block operator should also exhibit dynamical localization at small disorder. We will present our results on positivity of the Lyapunov exponents and the current state of our proof of localization based on a multiscale analysis approach. (Received September 01, 2012)

1085-82-152 **Jogia Bandyopadhyay***, Mathematical Sciences Building, One Shields Avenue, Davis, CA 95616. *Optimal Concentration for SU(1, 1) Coherent State Transforms and An Analogue of the Lieb-Wehrl Conjecture for SU(1, 1).*

We derive a lower bound for the Wehrl entropy in the setting of SU(1, 1). For asymptotically high values of the quantum number k, this bound coincides with the analogue of the Lieb-Wehrl conjecture for SU(1, 1) coherent states. The bound on the entropy is proved via a sharp norm bound. The norm bound is deduced by using an interesting identity for Fisher information of SU(1, 1) coherent state transforms on the hyperbolic plane $\mathbb{H}^2$ and a new family of sharp Sobolev inequalities on $\mathbb{H}^2$. To prove the sharpness of our Sobolev inequality, we need to first prove a uniqueness theorem for solutions of a semi-linear Poisson equation (which is actually the Euler-Lagrange equation for the variational problem associated with our sharp Sobolev inequality) on $\mathbb{H}^2$. Uniqueness theorems proved for similar semi-linear equations in the past do not apply here and the new features of our proof are of independent interest, as are some of the consequences we derive from the new family of Sobolev inequalities. (Received September 07, 2012)

1085-82-156 **Bruno Nachtergaele**, **Robert Sims** and **Gunter Stolz*** (stolz@uab.edu). *Quantum harmonic oscillator systems with disorder.*

We study many-body properties of quantum harmonic oscillator lattices with disorder. This includes dynamical localization in form of a zero-velocity Lieb-Robinson bound and exponential decay of correlation functions (static and dynamic, at zero temperature as well as at positive temperature). Our results cover finite and infinite oscillator systems. Finally, for some models of disordered oscillator systems which are almost surely gapless, we prove an area law for the averaged bipartite entanglement of ground states and thermal states as measured by the logarithmic negativity. (Received September 07, 2012)

1085-82-158 **Abel Klein*** (aklein@uci.edu), University of California, Irvine, Department of Mathematics, Irvine, CA 92697-3875. *Unique continuation principle for spectral projections of Schrödinger operators and Optimal Wegner estimates for non-ergodic random Schrödinger operators.* Preliminary report.

We prove a unique continuation principle for spectral projections of Schrödinger operators. We consider a Schrödinger operator $H = -\Delta + V$ on $\mathrm{L}^2(\mathbb{R}^d)$, and let H_Λ denote its restriction to a finite box Λ with either Dirichlet or periodic boundary condition. We prove unique continuation estimates of the type $\chi_I(H_\Lambda) W \chi_I(H_\Lambda) \geq \kappa\, \chi_I(H_\Lambda)$ with $\kappa > 0$ for appropriate potentials $W \geq 0$ and intervals I. As an application, we obtain optimal Wegner estimates at all energies for a class of non-ergodic random Schrödinger operators with alloy-type random potentials ('crooked' Anderson Hamiltonians). We also prove optimal Wegner estimates at the bottom of the spectrum with the expected dependence on the disorder (the Wegner estimate improves as the disorder increases), a new result even for the usual (ergodic) Anderson Hamiltonian. These estimates are applied to prove localization at high disorder for Anderson Hamiltonians in a fixed interval at the bottom of the spectrum. (Received September 07, 2012)

1085-82-200 **Eman Hamza*** (emanhamza@sci.cu.edu.eg), **Robert Sims** and **Günter Stolz**. *Lieb Robinson bounds in disordered quantum spin systems.*

In the past few years, Lieb-Robinson bounds have been shown to be powerful tools in turning the inherent locality of quantum spin systems into useful estimates to study dynamics as well as properties of ground states.

In this work we show that for general systems with short range interactions, zero velocity Lieb Robinson bound implies exponential decay of ground state correlations, up to an explicit correction. We also give an example of a system satisfying such bound, namely the isotropic xy chain in random exterior magnetic field. (Received September 10, 2012)

1085-82-234 **Virgil U Pierce*** (piercevu@utpa.edu), Department of Mathemaitcs, 1201 W University Drive, Edinburg, TX 78539. *The enumeration of odd valent maps with random matrix partition functions.*

The partition function of N-by-N hermitian random matrices has a natural interpretation in terms of a tau-function for the Toda lattice hierarchy. Continuum limits of the Toda hierarchy induce equations governing the behavior of the terms in the asymptotic expansion (in large N) of the logarithmic-partition function. These terms are also generating functions for the enumeration of maps (or ribbon graphs) partitioned by their genus. We have recently carried out this procedure in the case of maps with vertices of degree 3. We will illustrate the difficulties involved in lifting the results to higher valency numbers, in particular giving some explicit results in the case of degree 5 maps. (Received September 10, 2012)

1085-82-238 **Umar Islambekov***, uislambekov@math.arizona.edu, and **Robert Sims** and **Gerald Teschl**. *Lieb-Robinson bounds for the Toda lattice.*

We establish locality estimates, known as Lieb–Robinson bounds, for the Toda lattice. Under suitable assumptions on the initial condition, we also obtain similar estimates for certain perturbations of the Toda system. (Received September 10, 2012)

1085-82-250 **Vita O Borovyk***, Department of Mathematical Sciences, University of Cincinnati, Cincinnati, OH 45221, and **Michael Goldberg**. *Dispersive Estimates in Harmonic Lattice Systems in dimension 2.*

We consider infinite-volume quantum harmonic lattice systems and study the decay of the commutator norms in the large-time regime. Specifically, we look at the commutator of two finitely-supported observables that are moving apart with a fixed velocity and determine the precise dependence of the decay rate of the commutator norm on the velocity. It turns out that separation velocities can be naturally divided into four classes, according to the type of decay they produce. The minimal dispersion rate is of order $|t|^{-3/4}$, and the corresponding class consists of a unique (up to mirror symmetries) velocity. (Received September 11, 2012)

86 ► Geophysics

1085-86-157 **Cecile Penland*** (cecile.penland@noaa.gov), R/PSD3, NOAA/ESRL/PSD3, 325 Broadway, Boulder, CO 80305. *On multiplicative red noise in the fluctuating vorticity equation.*

We consider a multivariate linear system with multiplicative parameters that are themselves Ornstein-Uhlenbeck processes. In such a case, the moment equations are not closed, and approximate analytical expressions for comparison with numerical calculations are difficult to obtain. In fact, direct numerical calculations of these moments are often themselves difficult to obtain. We introduce a closure approximation based on a "slow noise limit" that allows accurate approximation to the vector mean of such systems. This approximation is used to investigate the role of multiplicative red noise on Rossby-Haurwitz waves on a super-rotating flow. (Received September 07, 2012)

1085-86-186 **Erich L Foster*** (erichlf@vt.edu), **Traian Iliescu** and **Zhu Wang**. *A Finite Element Discretization of the Streamfucntion Formulation of the Stationary Quasigeostrophic Equations of the Ocean.*

We present a conforming finite element discretization of the streamfunction formulation of the one-layer stationary Quasigeostrophic equations, which are a commonly used model for the large scale wind-driven ocean circulation. Optimal error estimates for this finite element discretization with the Argyris element are derived. Numerical tests for the finite element discretization of the Quasigeostrophic equations and two of its standard simplifications (the linear Stommel model and the linear Stommel-Munk model) are carried out. By benchmarking the numerical results against those in the published literature, we conclude that our finite element

discretization is accurate. Furthermore, the numerical results have the same convergence rates as those predicted by the theoretical error estimates. (Received September 10, 2012)

1085-86-284 **Chris Orum*** (orum@math.utah.edu), Mathematics Program, Badgley Hall, Eastern Oregon University, One University Boulevard, La Grande, OR 97850. *An algorithm for computing inverse bounds for microstructural parameters of heterogeneous composite media from effective property measurements.*

Forward bounds on the effective properties of composite materials obtained by the analytic continuation method developed by Bergman, Milton, and Golden and Papanicolaou, typically have the structure of Möbius transformations whose coefficients are polynomial functions of the microstructural parameters. Given an observed bulk effective property of a composite, the inverse problem is to determine a range of 'good' parameter values consistent with the observation. I discuss a general algorithm for inverting these types of forward bounds to obtain a system of algebraic equations whose solution set in parameter space bounds the region of admissible parameter values. The motivation comes from polar sea ice: as sea water freezes it rejects brine which remains trapped as liquid inclusions within a host matrix of pure ice. Thus sea ice a strongly heterogenous composite amenable to the forward theory for computing bounds on its effective complex permittivity. The inverse problem is to make inferences about the microstructure of the sea ice given an observed effective complex permittivity made by remote electromagnetic sensing. Parameters of interest include its brine volume fraction and a quantification of the separation between the brine inclusions. (Received September 11, 2012)

1085-86-285 **Eric J. Kostelich*** (kostelich@asu.edu), School of Mathematical & Statistical Sciences, Arizona State University, Box 871804, Tempe, AZ 85287. *Data assimilation methods for atmospheric models.* Preliminary report.

Data assimilation refers to the process by which initial conditions for geophysical models are determined from noisy observations, typically with maximum likelihood methods. One computationally efficient procedure is the Local Ensemble Transform Kalman Filter (LETKF), developed by the author and co-workers. This talk will describe some alternative formulations of the LETKF to address systematic bias in observations and to include an internal digital filter as a weak constraint. Preliminary results using a modern global atmospheric model will be described. (Received September 11, 2012)

92 ► Biology and other natural sciences

1085-92-19 **Richard A Neher** and **Marija Vucelja*** (vucelja@cims.nyu.edu), Courant Institute of Mathematical Sciences, 251 Mercer St, Rm 1119, New York, NY 10012, and **Mark Mezard** and **Boris I Shraiman**. *Emergence of clones in sexual populations.*

In sexual population, recombination reshuffles genetic variation and produces novel combinations of existing alleles, while selection amplifies the fittest genotypes in the population. If recombination is more rapid than selection, populations consist of a diverse mixture of many genotypes. In the opposite regime, selection can amplify individual genotypes into large clones. Such clones emerge, when the fitness advantage of the genotypes is large enough so that they grow to a significant fraction of the population, despite being broken down by recombination. Clonal condensation leads to a strong genetic heterogeneity of the population which is not adequately described by traditional population genetics measures. We point out the similarity between clonal condensation and the freezing transition in the Random Energy Model of spin glasses. Guided by this analogy we explicitly calculate as a function of the key parameters in a simple model of sexual populations, the probability that two individuals are genetically identical. We suggest that the "clonal condensation" phenomenon is relevant for the facultatively sexual population and for the quantitative understanding of the distribution of haplotypes in sexual populations. (Received July 15, 2012)

1085-92-67 **Gregory Roth**, Department of Evolution and Ecology, One Shield Avenue, Davis, CA 95616, and **Sebastian Schreiber*** (sschreiber@ucdavis.edu), Department of Evolution and Ecology, University of California, Davis, CA 95616. *Persistence of interacting, structured populations in stochastic environments.*

Individuals within any species exhibit differences in size, developmental state, or spatial location. These differences coupled with environmental fluctuations can have subtle effects on population persistence and species coexistence. To understand these effects, we provide a general theory for coexistence for nonlinear, multi species matrix models with stochastically varying parameters. Our coexistence criterion requires that at least one species has a positive stochastic growth rate when rare at each stationary distribution supporting only a subset of species.

When this coexistence condition holds, the community is stochastically persistent: the fraction of time that a species density goes below $\delta > 0$ approaches zero as δ approaches zero. To illustrate the use of this theory, we provide applications to predator-prey interactions in an autocorrelated environment, a stochastic LPA model, and spatial lottery models. These applications demonstrate that positive autocorrelations in temporal fluctuations can disrupt predator-prey coexistence, fluctuations in log-fecundity can facilitate persistence in structured populations, and long-lived, relatively sedentary competing populations are likely to coexist in spatially and temporally heterogenous environments. (Received August 29, 2012)

1085-92-76 **Brendan C Fry*** (bfry@math.arizona.edu), 617 N Santa Rita Ave, Tucson, AZ 85721, and **Timothy W Secomb**. *Simulation of Metabolic Blood Flow Regulation by Wall-Derived and Red-Blood-Cell-Derived Mechanisms: Responses to Hemodilution.* Preliminary report.

Blood flow in the microcirculation is regulated according to local metabolic demands of the tissue; however, the mechanism for this regulation is not entirely known. The purpose of this investigation is to analyze the effects of metabolic flow regulation by signals derived from the vessel wall and derived from red blood cells (RBCs), in response to a reduction in RBC volume fraction (HD). A theoretical model is used to simulate blood flow, oxygen transport, and flow regulation in microvascular networks with realistic heterogeneous structures. If HD is reduced (hemodilution), the initial effects are increased blood flow rates due to the reduction in apparent viscosity, but decreased RBC fluxes. If the metabolic signal is assumed to originate solely from a RBC-dependent mechanism, the model predicts that flow regulation will then cause a reduction in blood flows and further decreases in RBC fluxes. If the metabolic signal is assumed to originate instead from a wall-dependent mechanism, flow regulation causes a further increase in flow, such that the initial decrease in RBC flux is partially reversed. These findings suggest that a RBC-independent mechanism of metabolic flow regulation is required for an appropriate physiological response to hemodilution. NIH grant HL070657. (Received August 30, 2012)

1085-92-77 **Hayriye Gulbudak*** (hgulbudak@ufl.edu), University of Florida, Gainesville, FL 32611, and **Maia Martcheva** (maia@ufl.edu), University of Florida, Gainesville, FL 32611. *Modelling Culling in Avian Influenza.*

The emerging threat of a human pandemic caused by the H5N1 avian influenza virus strain magnifies the need for controlling the incidence of H5N1 infection in domestic bird populations. Culling is one of the most widely used control measures and has proved effective for isolated outbreaks. However, the socio-economic impacts of mass culling, in the face of a disease which has become endemic in many regions of the world, can affect the implementation and success of culling as a control measure. Mathematical modeling may help to understand the dynamics of Avian Influenza under different culling approaches. We incorporate culling into an SI model by considering the per-capita culling rates to be general functions of the number of infected birds. Complex dynamics of the system, such as backward bifurcation and forward hysteresis, along with bi-stability, are detected and analyzed for two distinct culling scenarios in the model. In these cases, employing other control measures temporarily can drastically change the dynamics of the solutions to a more favorable outcome for disease control. (Received September 02, 2012)

1085-92-193 **Andrea K Barreiro*** (abarreiro@smu.edu), **Eli Shlizerman**, **Eric Shea-Brown** and **J Nathan Kutz**. *Low-dimensional descriptions of neural networks.* Preliminary report.

Biological neural circuits display both spontaneous asynchronous activity, and complex, yet ordered activity while actively responding to input. When can model neural networks demonstrate both regimes? Recently, researchers have demonstrated this capability in large, recurrently connected neural networks, or "liquid state machines", with chaotic activity. We study the transition to chaos in a family of such networks, and use principal orthogonal decomposition techniques to provide a lower-dimensional description of network activity. We find that key characteristics of this transition depend critically on whether a fundamental neurobiological constraint — that most neurons are *either* excitatory or inhibitory — is satisfied. (Received September 10, 2012)

1085-92-207 **Carrie Manore*** (cmanore@tulane.edu), **Helen Wearing**, **James Hyman** and **Sen Xu**. *A Mosquito-borne Disease Model Comparing Dynamics of Chikungunya and Dengue.* Preliminary report.

Chikungunya is a re-emerging mosquito-borne infectious disease that is spreading rapidly in Asia with recent new epidemics in Italy and several Indian Ocean islands. Mosquitoes in Europe and the Americas can transmit chikungunya, so both regions are considered to be at risk. We design and analyze an ordinary differential equation disease model with mosquito dynamics in order to compare chikungunya with dengue fever, which is common in South and Central America. We parameterize the model using current literature and existing data and compute

conditions for stability of the disease free equilibrium. Long term and transient dynamics of chikungunya are then compared to dynamics of dengue. We show that dengue and chikungunya have different levels of sensitivity to different parameters in the model, indicating that the U.S. may be at risk for a chikungunya outbreak, were it to be introduced. Our results suggest areas of future research that are important to understanding and controlling the spread of chikungunya. (Received September 10, 2012)

1085-92-222 **Brian K Mannakee** and **Ryan N Gutenkunst*** (rgutenk@email.arizona.edu). *Protein Domains With Greater Influence On Network Dynamics Evolve More Slowly.* Preliminary report.

A fundamental question for evolutionary biology is why different proteins evolve at dramatically different rates. In particular, it is controversial to what degree the functional importance of a protein affects its evolutionary rate, in part because importance can only be experimentally measured crudely, using knock-outs. Here we leverage biochemically-detailed systems biology simulation models to measure importance much more finely. We define dynamical influence as the integrated sensitivity of network dynamics to changes in the rates of reactions each domain of a protein participates in. We show that protein domains with greater dynamical influence evolve more slowly, suggesting that functional importance does indeed affect protein evolutionary rate. We also show that dynamical influence and knock-out essentiality are not strongly correlated, suggesting that many cellular reactions are essential to life but have little quantitative effect on fitness. More broadly, our work shows that detailed simulation models can offer insight not only into how a system functions, but also how it evolves. (Received September 10, 2012)

1085-92-247 **W. Felder*** (felderw@math.oregonstate.edu) and **E. Waymire**. *On The Drift Paradox in a regime-switching model.* Preliminary report.

This talk is motivated by the paper of F. Lutscher, E. Pachepsky, and M. Lewis, *The Effect of Dispersal Patterns on Stream Populations* SIAM Rev. Vol. 47 No. 4 pp. 749-772, and likewise attempts to answer the drift paradox. We consider a probabilistic model for a population of organisms living in a one dimensional environment with drift towards an absorbing boundary. Two phases exist, with birth/death style demographics governing the evolution of the immobile phase, some form of advection-dispersion governing the evolution of the mobile phase, and a regime-switching mechanism linking the two. Some preliminary results will be indicated for comparison to the aforementioned more analytic approach. In particular it will be shown that, under the regime-switching framework presented here, and in contrast to the results given in the cited work, for any finite advection speed (no matter how large) there is a critical length of the domain above which the population can persist. This research is partially supported by NSF grant DMS1122699. (Received September 10, 2012)

1085-92-261 **Thomas C Bishop*** (bishop@latech.edu), Louisiana Tech University, Biomedical Engineering Center/BEC 103, 818 Nelson Ave, P.O. Box 10157 , Ruston, LA 71272. *DNA and chromatin as space curves constructed with 1 to 1,000,000 base pairs.* Preliminary report.

Given a sequence representing 1 to 1,000,000 base pairs of DNA, a model of double stranded DNA can be constructed by stacking successive base pairs together using known biophysical data. The integration is sufficiently fast to support interactive modeling. If nucleosome locations are also known, either from experiment or theory, then it is possible to construct models of entire chromosomes in near real time. Conformations of DNA and chromatin for the mouse mammary tumor virus promoter complex and for all sixteen chromosomes of the yeast genome are presented as case studies to demonstrate the utility and problems with this approach.

A web based version of these tools is available via the Chromatin Folding tab at www.latech.edu/~bishop. (Received September 11, 2012)

1085-92-265 **Julie C Mitchell***, 480 Lincoln Dr., Madison, WI 53703, and **Omar NA Demerdash**, 433 Babcock Dr., Madison, WI 53703. *Density-cluster NMA: A new protein decomposition technique for coarse-grained normal mode analysis.*

Normal mode analysis has emerged as a useful technique for investigating protein motions on long time scales. This is largely due to the advent of coarse-graining techniques, particularly Hooke's Law-based potentials and the rotational-translational blocking (RTB) method for reducing the size of the force-constant matrix, the Hessian. Here we present a new method for domain decomposition for use in RTB that is based on hierarchical clustering of atomic density gradients, which we call Density-Cluster RTB (DCRTB). The method reduces the number of degrees of freedom by 85-90% compared with the standard blocking approaches. We compared the normal modes from DCRTB against standard RTB using 1-4 residues in sequence in a single block, with good agreement between the two methods. We also show that Density-Cluster RTB and standard RTB perform well in capturing

the experimentally determined direction of conformational change. Significantly, we report superior correlation of DCRTB with B-factors compared with 1-4 residue per block RTB. Finally, we show significant reduction in computational cost for Density-Cluster RTB that is nearly 100-fold for many examples. (Received September 11, 2012)

1085-92-270 **Joseph P Stover*** (joseph.stover@gmail.com), **Bruce E Kendall** and **Gordon A Fox**. *Effects of demographic and competitive heterogeneity on species coexistence.*

Individual variability within species in competitive ability is prevalent in natural populations, but ecological models of competition usually assume species are homogeneous. Competitive heterogeneity may arise from variation in resource access or usage, from variation in competitive ability, or from variation in behavioral traits such as aggressiveness or boldness. We generalize the simple two-species Lotka-Volterra competition model to include a heterogeneous species. The heterogeneous species may have variability in both intra-specific and inter-specific competition parameters and in individual demographic traits (reproduction and mortality). We show that competitive heterogeneity can change the region of parameter space where coexistence occurs. Depending on the structure of the heterogeneous competitive interactions and their relationships with demographic traits, competitive heterogeneity can make the heterogeneous species more prone to invasion or more able to invade, hence turning coexistence into exclusion, or vice versa. (Received September 11, 2012)

1085-92-277 **David Cai*** (cai@cims.nyu.edu). *Causality Analysis and Functional Connectivity of Neuronal Network Dynamics.*

How to characterize causality and functional connectivity of neuronal network dynamics is an important and challenging scientific question. For linear stochastic systems, Granger Causality analysis is an effective tool to address the issue of causal influence. Here we demonstrate that Granger Causality can be successfully extended to analyze network connections of nonlinear neuronal network dynamics of integrate-and-fire type. We address why Granger Causality can be used to analyze this type of nonlinear network systems and reveal the underlying mechanism for this effective linearization of nonlinear neuronal network dynamics. We will further present a kinetic theory approach to study functional connectivity arising from network dynamics of neuronal populations and analyze fluctuations induced by the dynamics of the network and induced by the topology of the network, such as random networks and scale-free networks. Finally we will briefly address the issue of anatomical connectivity and functional connectivity in the brain. (Received September 11, 2012)

93 ► Systems theory; control

1085-93-13 **Paul A Fuhrmann*** (fuhrmannbgu@gmail.com), 53 Tagore Str., Tel Aviv, Israel, and **Uwe Helmke**. *Controllability, observability of networks of linear systems.* Preliminary report.

This paper aims at a better understanding of controllability and observability properties of heterogeneous networks of linear systems. It extends prior work by Hara et al.[2009], who characterized controllability for homogeneous networks of identical linear SISO systems. Our approach is based on extending the classical notion of strict system equivalence to networks of linear systems. We survey and extend known characterizations for controllability and observability for arbitrary interconnected linear MIMO systems. Both static and dynamic interconnection laws are considered and various applications to classes of homogeneous and heterogeneous networks are derived.

Key words: Networks, linear systems, system equivalence, controllability, observability, interconnections.

S. Hara, T. Hayakawa and H. Sugata, "LTI systems with generalized frequency variables: A unified framework for homogeneous multi-agent dynamical systems", *SICE J. of Contr. Meas. and System Integration*,2,299-306, 2009. (Received June 10, 2012)

1085-93-29 **Michael Malisoff*** (malisoff@lsu.edu), Department of Mathematics, 303 Lockett Hall, Louisiana State University, Baton Rouge, LA 70803-4918. *Asymptotic Stabilization for Feedforward Systems with Delayed Feedbacks.*

Time-delayed systems are a natural framework for analyzing many biological and engineering models. Here we study a problem of state feedback stabilization of time-varying feedforward systems with a pointwise delay in the input. Our approach relies on a time-varying change of coordinates and Lyapunov-Krasovskii functionals. Our result applies for any given constant delay, and provides uniformly globally asymptotically stabilizing controllers of arbitrarily small amplitude. The closed-loop systems enjoy input-to-state stability properties with respect to additive uncertainty on the controllers. We illustrate our work using a tracking problem for a model for high

level formation flight of unmanned air vehicles. We will review all of the necessary background on control theory, so no prior exposure to controls will be needed to understand this talk. This work is joint with Frederic Mazenc from INRIA in France. (Received August 28, 2012)

94 ► Information and communication, circuits

1085-94-256 **Misha Stepanov*** (stepanov@math.arizona.edu), Department of Mathematics, University of Arizona, 617 N. Santa Rita Ave., Tucson, AZ 85721. *Instantons causing iterative decoding to cycle.*

It is speculated that the most probable channel noise realizations (instantons) that cause the iterative decoding of low-density parity-check codes to fail make the decoding not to converge. A simple example is given of an instanton that is not a pseudo-codeword and causes iterative decoding to cycle. A method of finding the instantons for large number of iterations is presented and tested on Tanner's [155, 64, 20] code and Gaussian channel. The inherently dynamic instanton with effective distance of 11.475333 is found. (Received September 11, 2012)

2010 MATHEMATICS SUBJECT CLASSIFICATION

Compiled in the Editorial Offices of MATHEMATICAL REVIEWS and ZENTRALBLATT MATH

00 General
01 History and biography
03 Mathematical logic and foundations
05 Combinatorics
06 Order, lattices, ordered algebraic structures
08 General algebraic systems
11 Number theory
12 Field theory and polynomials
13 Commutative rings and algebras
14 Algebraic geometry
15 Linear and multilinear algebra; matrix theory
16 Associative rings and algebras
17 Nonassociative rings and algebras
18 Category theory; homological algebra
19 K-theory
20 Group theory and generalizations
22 Topological groups, Lie groups
26 Real functions
28 Measure and integration
30 Functions of a complex variable
31 Potential theory
32 Several complex variables and analytic spaces
33 Special functions
34 Ordinary differential equations
35 Partial differential equations
37 Dynamical systems and ergodic theory
39 Difference and functional equations
40 Sequences, series, summability
41 Approximations and expansions
42 Fourier analysis
43 Abstract harmonic analysis
44 Integral transforms, operational calculus
45 Integral equations
46 Functional analysis
47 Operator theory
49 Calculus of variations and optimal control; optimization
51 Geometry
52 Convex and discrete geometry
53 Differential geometry
54 General topology
55 Algebraic topology
57 Manifolds and cell complexes
58 Global analysis, analysis on manifolds
60 Probability theory and stochastic processes
62 Statistics
65 Numerical analysis
68 Computer science
70 Mechanics of particles and systems
74 Mechanics of deformable solids
76 Fluid mechanics
78 Optics, electromagnetic theory
80 Classical thermodynamics, heat transfer
81 Quantum theory
82 Statistical mechanics, structure of matter
83 Relativity and gravitational theory
85 Astronomy and astrophysics
86 Geophysics
90 Operations research, mathematical programming
91 Game theory, economics, social and behavioral sciences
92 Biology and other natural sciences
93 Systems theory; control
94 Information and communication, circuits
97 Mathematics education

0192-5857(2012)33:4;1-#

Periodicals postage paid at Providence, RI and additional mailing offices

Abstracts of Papers Presented to the AMS
ISSN 0192-5857
American Mathematical Society
201 Charles Street, Providence, RI 02904-2294 USA
GST No. R121892046