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PAPERS PRESENTED AT MEETINGS

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MEETING #	DATE	PLACE	ABSTRACT DEADLINE	ABSTRACT ISSUE
1084	October 20–21, 2012	Akron, OH	EXPIRED	Vol 33, No. 4
1085	October 27–28, 2012	Tucson, AZ	EXPIRED	Vol 33, No. 4
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

ROCHESTER, NY, September 22–23, 2012

Abstracts of the 1082nd Meeting.

00 ► General

1082-00-103 **Christopher A Wood*** (caw4567@rit.edu). *Characterization Results for the L(2,1)-Labeling Problem on Trees.*

An $L(2,1)$-labeling of a graph G is a vertex labeling $f : V(G) \to \{0\} \cup \mathbb{Z}^+$ such that $|f(u) - f(v)| \geq 2$ for all $uv \in E(G)$ and $|f(u) - f(v)| \geq 1$ if $d(u,v) = 2$. In the context of this labeling scheme, we define the *span of an $L(2,1)$-labeling f* on a graph G is the max $f(u)$ for all $u \in V(G)$. The *span of a graph G*, denoted $\lambda_{2,1}(G)$, is the minimum span of all $L(2,1)$-labelings on G. An $L(2,1)$-labeling f on G whose span is equal to the span of G is called a span labeling of G.

Griggs and Yeh showed that $\lambda_{2,1}(T) \in \{\Delta(T)+1, \Delta(T)+2\}$ for all trees T, and further concluded that the problem of recognizing the two classes of trees is NP-hard. However, Chang and Kuo have since provided a polynomial-time algorithm that can decide whether or not the label span for a tree T is $(\Delta(T)+1)$. The problem of characterizing the label span of a tree T based solely on its structural properties is still determined to be very difficult. In this work we provide support for this notion by showing that there exists an infinite amount of forbidden subtree classes that we can construct from existing $(\Delta(T)+1)$ trees. (Received June 29, 2012)

1082-00-140 **Cristian I. Tiu*** (ctiu@buffalo.edu), 366 Jacobs, North Campus, School of Management, University at Buffalo, Buffalo, NY 14260, and **Uzi Yoeli**. *Asset pricing with endogenous disasters.* Preliminary report.

We develop a parsimonious model with endogenous disasters generated through the dynamics of the labor. In our simple setting, with one continuous state variable and CRRA agents, we solve for prices in closed form and show that we can account for the high (and countercyclical) equity premium and volatility observed in the U.S. stock market with relatively modest levels of risk aversion. The model produces predictability patterns observed in the data, with the in-sample predictors derived from our model being stronger than the observed dividend yield. Having generated disasters through a labor mechanism, we are able to validate our model by calibrating it to labor data, such as labor's share of income, while testing its asset pricing predictions, such as the magnitude of the drop in consumption in an economic collapse. We find support for our model's implication that more

capital intensive economies experience larger disasters. Finally, we discuss possible extensions of this model that may be capable to address a variety of stylized facts of asset prices. (Received July 03, 2012)

1082-00-184 **Armen R. Kherlopian**, **Willemijn Groenendaal**, **Francis A Ortega**, **Andrew C Zygmunt**, **Trine Krogh-Madsen** and **David J Christini*** (dchristi@med.cornell.edu), Weill Cornell Medical College, 1300 York Ave., Box 161, New York, NY 10065. *Expanding the dynamical phase space of electrophysiological protocols to tune cardiac models.* Preliminary report.

Cardiac mathematical models are widely used to illuminate a wide range of physiological and pathophysiological electrophysiological dynamics, as well as to help guide drug and device development. While there have been myriad advances in the improvement of cardiac models, the identification of model parameters, such as ion-channel conductances and rate constants, remains a challenging problem. This talk will describe recent efforts to improve such parameter identification by combining dynamically rich electrophysiology protocols with automated computational search methods. (Received July 06, 2012)

1082-00-200 **R Virk*** (virk@math.colorado.edu). *Convolution exercises with the geometric Hecke algebra.* Preliminary report.

I will report on my ongoing work relating geometric braid group actions with the (geometric) Hecke algebra. (Received July 08, 2012)

1082-00-237 **Mehran Ebrahimi*** (mehran.ebrahimi@sri.utoronto.ca), Dept. of Medical Biophysics, University of Toronto, 2075 Bayview Ave, Toronto, Ontario M4N3M5, Canada, and **Anne L. Martel** (anne.martel@sri.utoronto.ca), Dept. of Medical Biophysics, University of Toronto, 2075 Bayview Ave., Toronto, Ontario M4N3M5, Canada. *Evaluating thin-plate spline registration of the breast in two supine positions.*

Breast MRI is performed prior to breast conserving surgery in order to assess the location and extent of the lesion. Since surgery is performed in the supine position, it is desirable to also acquire MR images in a supine position. A method of acquiring high quality supine images has recently been developed however in most clinical MR scanners the arm of the patient has to be placed parallel to the body, whereas the arm is placed in an outstretched position during surgery. The aim of this study is to determine whether it is possible to register supine MR images to the patient during surgery using surface fiducial markers despite this difference in arm position. In this abstract, we examine a Thin-Plate Spline (TPS) registration scheme to match MR images acquired in these two configurations. We study the relationship between the number of markers used and the registration errors for a volunteer dataset. Furthermore, preliminary registration experiments on a patient dataset are presented. (Received July 09, 2012)

1082-00-280 **Hongzhong Zhang*** (hz2244@columbia.edu), 1255 Amsterdam Ave, 1005, New York, NY 10027. *Correlated reflected Brownian motions and 2-CUSUMS.*

In this talk we study the first hitting time of the two negatively correlated drifted Brownian motion to a pre-specified level. Using martingale and PDE argument, weshow that the expected hitting time for a general negative correlation ρ is bounded by the case when $\rho = 0$ and the case when $\rho = -1$. As an application of this, we prove the asymptotic optimality of 2-CUSUM rule when noises are negatively correlated. (Received July 10, 2012)

03 ► Mathematical logic and foundations

1082-03-8 **Aisha Ahmed Amer*** (eamer_80@yahoo.com), School of Mathematical Sciences, Faculty of Science and Technology, Universiti Kebangsaan Malaysia, MALAYSIA, MO, Malaysia, and **Maslina Darus** (maslina@ukm.com), School of Mathematical Sciences, Faculty of Science and Technology, Universiti Kebangsaan Malaysia, MALAYSIA, Malaysia. *Simple Sufficient Conditions for Double Integral Operators Concerning Starlike of Order β.* Preliminary report.

Problem statement: Double integral operators of Miller and Mocanu are noted to be an interesting topic to discuss in a decade to come. The theory of differential subordinations was used to show that the analytic function f is starlike of order in the open unit disk U.

Approach: With the same manner, we discuss here some conditions for f to be starlike of order β in U. The second-order differential inequalities and double integral operators will be our main concerned here.Several other results are also considered.

Results: Having the analytic function, some interesting properties will be obtained. Relevant connections of the results,shall be presented in the paper.In fact, various other known results are also pointed out.We also find some interesting corollaries on the class of normalized analytic functions in the open unit disk.

Conclusion: Therefore, many interesting results could be obtained and we also derive some interesting properties .We conclude this study with some suggestions for future research,one direction is to study other classes of analytic functions on the class of normalized analytic functions in the open unit disk. (Received December 27, 2011)

1082-03-35 **G. Muhiuddin*** (chishtygm@gmail.com), University of Tabuk, Faculty of Science, Department of Mathematics, Tabuk, Saudi Arabia. *On (alpha,beta)-derivations in BCI-algebras.* Preliminary report.

The notion of (regular) (α, β)-derivations of a BCI-algebra X is introduced, some useful examples are discussed, and related properties are investigated. Condition for a (α, β)-derivation to be regular is provided. The concepts of a $d_{(\alpha,\beta)}$-invariant (α, β)-derivation and α-ideal are introduced, and their relations are discussed. Finally, some results on regular (α, β)-derivations are obtained. (Received May 17, 2012)

05 ► Combinatorics

1082-05-4 **Agelos Georgakopoulos** and **Peter Winkler*** (peter.winkler@dartmouth.edu), Dept. of Mathematics, Kemeny Hall, Dartmouth College, Hanover, NH 03755-3551. *Edge-Cover by Random Walk.*

We show that random walk on a graph with m edges will cover all the edges in expected time at most $2m^2$, and all edges in both directions in time $3m^2$. The results extend to graphs with variable edge-lengths and to Brownian motion on a network. (Received June 27, 2012)

1082-05-16 **dara moazzami*** (dmoazzami@ut.ac.ir), University of Tehran, School of Engineering, Faculty of Engineering, Faculty of Engineering Science, 14395-195 Tehran, Tehran, Iran, and **bahareh bafandeh**. *The cth order Edge-Tenacity of a Graph.* Preliminary report.

Numerous networks as, for example, road networks, electrical networks and communication networks can be modeled by a graph. Many attempts have been made to determine how well such a network is "connected" or stated differently how much effort is required to break down communication in the system between at least some nodes.

Two well-known measures that indicate how "reliable" a graph is are the "Tenacity" and "Edge-tenacity" of a graph.

The objective of this paper is to study the generalized concept of edge-tenacity and determining this quantity for complete n-partite graphs.

For an integer c, 1≤c≤ |V(G)|-1,we define the *cth-order* edge-tenacity of a graph G as

$$\mathrm{T}_c(\mathrm{G})=\min\{\ \tfrac{|X|+\tau(G-X)}{\omega(G-X)-c}\ |\mathrm{X}\subseteq \mathrm{E(G)} \text{ and } \omega(\mathrm{G\text{-}X})>\mathrm{c}\ \}$$

Where the minimum is taken over every edge-cutset X that separates G into ω(G-X) components,and by $\tau(G-X)$ we denote the order of a largest component of G. (Received March 25, 2012)

1082-05-33 **Eric Swartz*** (eswartz@math.binghamton.edu), Department of Mathematical Sciences, Binghamton University, Binghamton, NY 13902. *Locally 2-arc transitive covers of complete bipartite graphs.*

Cheryl Praeger's normal quotient method has made the study of certain families of finite graphs (for instance, s-arc transitive and locally s-arc transitive graphs) more approachable by dividing the problem into two parts: (I) Study the "basic graphs," those graphs in the family that are not covers of anything but "trivial" graphs; (II) Study the covers of the basic graphs. While (I) has been studied extensively, not much work has been done toward (II). In this talk, I will discuss how voltage graphs can be used to find covers of graphs where certain symmetries "lift," and specifically look at the problem of determining the locally 2-arc transitive covers of $K_{m,n}$. (Received May 16, 2012)

1082-05-54 **Sam Northshield*** (northssw@plattsburgh.edu). *The Fibonacci Shift.*

Every integer can be represented as a sum of distinct Fibonacci numbers $F(n)$, $n \geq 2$. Although such a representation is generally not unique, the replacement of each Fibonacci number by the next one in such a representation actually makes a well-defined function $\sigma(n)$ on the positive integers; the Fibonacci shift .

We show that $\sigma(n)$ is a Beatty sequence: $\sigma(n) = \lfloor n\phi + 1/\phi \rfloor$where ϕ is the golden ratio. The complementary Beatty sequence is $\tau(n) := \lfloor n\phi^2 - 1 \rfloor$.

The sequence $b(n)$ defined by $b(\sigma(n)) = b(n)$ and $b(\tau(n)) = b(n) + b(n-1)$ is an analogue of Stern's sequence and shares many of its properties. Combinatorially, $b(n+1)$ counts the number of representations of n as a sum of distinct Fibonacci numbers.

If $k/F(n)$ increases to x ($\in [0, 1/\phi]$), then $b(k)/b(F(n)+k)$ converges to a value, say, $B(x)$. The function $B(x)$ is singular and is an analogue of Conway's box function.

Knuth introduced "Fibonacci multiplication" on the positive integers and showed it was associative. We use $\sigma(n)$ to give a short proof of this fact.

We create the "Fibadic integers" based on a valuation defined by $\sigma(n)$. (Received June 12, 2012)

1082-05-92 **Anant Godbole*** (godbolea@etsu.edu). *Some results on pattern avoidance, pattern containment, and average case behavior for permutations and words.* Preliminary report.

This talk will provide a survey of several somewhat related problems. Starting with recent work on the minimal number of $(n+1)$-permutations needed to cover all n-permutations, we will ask what relation this has to the structure of the pattern containment poset, and whether the logarithmic term in the minimal bound mentioned above is extraneous. (If the log term can be removed, it would provide an example of an efficient covering, in much the same way as speculated, correctly and in a different context, by the Erdős-Hanani conjecture.) We will move on to statistics that measure the correlation between two permutations. Finally, we will mention results on avoidance in graphs, and joint distributions of statistics that arise in classical single stack sorting of words and permutations. This is joint work with Taylor Allison, Kristen Bartosz, Bill Kay, Mike Earnest, Sam Gutekunst, Sam Hopkins, Jennifer Herdan, Katie Hawley, Yevgeniy Rudoy, and Morgan Weiler. (Received June 27, 2012)

1082-05-97 **Michael Hallaway**, **Cong X. Kang** and **Eunjeong Yi*** (yie@tamug.edu), Galveston, TX 77553. *On Metric Dimension of Permutation Graphs.* Preliminary report.

The *metric dimension* $\dim(G)$ of a graph G is the minimum number of vertices such that every vertex of G is uniquely determined by its vector of distances to the set of chosen vertices. Let G_1 and G_2 be disjoint copies of a graph G, and let $\sigma : V(G_1) \to V(G_2)$ be a permutation. Then, a *permutation graph* $G_\sigma = (V, E)$, in the sense of Chartrand and Harary, has the vertex set $V = V(G_1) \cup V(G_2)$ and the edge set $E = E(G_1) \cup E(G_2) \cup \{uv \mid v = \sigma(u)\}$. We show that $2 \leq \dim(G_\sigma) \leq n-1$ for any connected graph G of order $n \geq 3$. We give examples showing that neither is there a function f such that $\dim(G) < f(\dim(G_\sigma))$ for all pairs (G, σ), nor is there a function g such that $g(\dim(G)) > \dim(G_\sigma)$ for all pairs (G, σ). Further, we characterize permutation graphs G_σ satisfying $\dim(G_\sigma) = n-1$ when G is a complete k-partite graph, a cycle, or a path on n vertices. (Received June 28, 2012)

1082-05-102 **Xiaodong Xu**, Guangxi Academy of Sciences, Nanning, Guangxi 530007, Peoples Rep of China, and **Stanisław Radziszowski*** (spr@cs.rit.edu), Department of Computer Science, Rochester Institute of Technology, Rochester, NY 14623. *Bounds onShannon Capacity and Ramsey Numbers from Product of Graphs.*

This talk concerns Shannon capacity of channels in the context of classical Ramsey numbers. We overview some of the results on capacity of noisy channels modelled by graphs, and how some constructions may contribute to our knowledge of this capacity. We present an improvement to the constructions by Abbott and Song and thus establish new lower bounds for a special type of multicolor Ramsey numbers. We prove that our construction implies that the supremum of the Shannon capacity over all graphs with independence number 2 cannot be achieved by any finite graph power. This can be generalized to graphs with any bounded independence number. (Received June 29, 2012)

1082-05-104 **Sergi Elizalde*** (sergi.elizalde@dartmouth.edu), Department of Mathematics, Dartmouth College, 6188 Kemeny Hall, Hanover, NH 03755. *Consecutive patterns in permutations.*

A permutation π avoids a consecutive pattern σ if no subsequence of adjacent entries of π is in the same relative order as the entries of σ. For example, alternating permutations are those that avoid the consecutive patterns 123 and 321.

I will discuss some results on the enumeration of permutations that avoid consecutive patterns. One of the tools used is the cluster method of Goulden and Jackson, based on inclusion-exclusion, which reduces the enumeration of these permutations to counting linear extensions of certain posets. We obtain differential equations for the generating functions counting occurrences of certain consecutive patterns.

I will also show that among consecutive patterns of length m, the pattern $12\dots m$ is the most avoided one, while the pattern $12\dots(m-2)m(m-1)$ is the least avoided one. (Received June 29, 2012)

1082-05-111 **Miklos Bona*** (bona@ufl.edu), Department of Mathematics, University of Florida, Gainesville, FL 32611-8105. *A new upper bound for 1324-avoiding permutations.*

Using an injective map of permutations to pairs of words over a 4-element alphabet, we prove that the number of permutations of length n avoiding the pattern 1324 is less than 13.92^n. (Received July 01, 2012)

1082-05-119 **Ronald J. Gould*** (rg@mathcs.emory.edu), Department of Math and CS, Emory University, Atlanta, GA 30345. *On Chorded Cycles.*

A *chord* in a cycle is an edge between nonconsecutive vertices of the cycle. There are many results about the existence of cycles, collections of cycles, or 2-factors. But there are far fewer results about the existence of chorded cycles or collections of chorded cycles. We survey what is known about chorded cycles and present a new result about the existence of a collection of k doubly chorded cycles. (Received July 02, 2012)

1082-05-122 **Alan Shuchat**, **Randy Shull**, **Ann N Trenk*** (atrenk@wellesley.edu) and **Lee C West**. *Unit Interval Graphs of Mixed Intervals.* Preliminary report.

The class of unit interval graphs has a lovely characterization as those interval graphs with no induced claw $K_{1,3}$. The characterization remains the same whether the intervals used in the intersection representation are all open intervals or all closed intervals. In recent work, Rautenbach and Szwarcfiter characterize the broader class that arises when both open and closed intervals of unit length are permitted. In this talk we consider the same problem when unit length mixed intervals of the form $(x, x+1]$ and $[x, x+1)$ are also allowed. We give a structural characterization of this class of graphs. (Received July 02, 2012)

1082-05-131 **Cheyne Homberger*** (cheyne42@ufl.edu), Department of Mathematics, University of Florida, PO Box 118105, Gainesville, FL 32611. *Expected Patterns in Permutation Classes.*

In the set of all patterns in S_n, it is clear that each k-pattern occurs equally often. If we instead restrict to the class of permutations avoiding a specific pattern, the situation quickly becomes more interesting. Miklós Bóna recently proved that, surprisingly, if we consider the class of permutations avoiding the pattern 132, all other non-monotone patterns of length 3 are equally common. In this paper we examine the class $Av(123)$, and give exact formula for the occurrences of each length 3 pattern. While this class does not break down as nicely as $Av(132)$, we find some interesting similarities between the two and prove that the number of 231 patterns is the same in each. (Received July 03, 2012)

1082-05-135 **Timothy D LeSaulnier**, **Kevin G Milans**, **Derrick Stolee*** (s-dstolee1@math.unl.edu) and **Douglas B West**. *Ordered Ramsey Theory and Track Representations of Graphs.*

We introduce an ordered version of Ramsey numbers for hypergraphs, where the vertex sets of the target and hosts are linearly ordered. In this model, we obtain bounds on the ordered Ramsey numbers of the k-uniform hypergraph whose edge set consists of the sets of k consecutive vertices in the linear order on the vertex set. We apply these bounds to study the minimum number of interval graphs whose union is the line graph of the complete graph with n vertices. Heldt, Knauer, and Ueckerdt conjectured that this number grows with n. We prove the conjecture, showing that the growth rate is between $\Omega(\log^* n)$ and $O(\log\log n)$. (Received July 03, 2012)

1082-05-141 **sarah-marie belcastro*** (smbelcas@toroidalsnark.net). *Snarks on the Klein Bottle.* Preliminary report.

It is known that for every nonorientable surface—except the Klein bottle—there is at least one snark that embeds polyhedrally on that surface. What is the case with the Klein bottle? Does there, or does there not, exist a snark that embeds polyhedrally on the Klein bottle?

In this work, we investigate the existence (and absence!) of snarks polyhedrally embedded on the Klein bottle. From a dual perspective, we investigate which 6-chromatic triangulations of the Klein bottle have Grünbaum colorings.

Okay, okay, we'll end the suspense: We have found some snarks that embed polyhedrally on the Klein bottle. And, we have found that every triangulation containing certain 6-critical graphs on the Klein bottle must have a Grünbaum coloring. (Received July 03, 2012)

1082-05-148 **Michael Ferrara*** (michael.ferrara@ucdenver.edu), **Timothy LeSaulnier**, **Casey Moffatt** and **Paul Wenger**. *The Asymptotics of the Potential Function.*

A nonnegative integer sequence π is graphic if there is some (simple) graph G such that π is the degree sequence of G. In this case we say that G is a realization of π. Given a graph H, a graphic sequence π is *potentially H-graphic* if there is some realization of π that contains H as a subgraph.

In 1991, Erdős, Jacobson and Lehel posed the following question:

Determine the minimum integer $\sigma(H,n)$ such that every n-term graphic sequence with sum at least $\sigma(H,n)$ is potentially H-graphic.

As the sum of the terms of π is twice the number of edges in any realization of π, the Erdős-Jacobson-Lehel problem can be viewed as a potential degree sequence relaxation of the Turán problem.

While the exact value of $\sigma(H,n)$ has been determined for a number of specific classes of graphs, very little is known about the parameter for arbitrary H. Here, we determine $\sigma(H,n)$ asymptotically for all H, thereby providing an Erdős-Stone-Simonovits-type theorem for the Erdős-Jacobson-Lehel problem. (Received July 05, 2012)

1082-05-155 **Breeanne Baker*** (bab207@lehigh.edu) and **Garth Isaak**. *Characterization Theorems for the k-Fixed-Endpoint Path Partition Problem.*

Given a graph G and a set T of k vertices, a k-fixed-endpoint path partition of G with respect to T is a set of vertex-disjoint paths which cover the vertices of G and in which every vertex in T is an endpoint of a path. The k-fixed-endpoint path partition problem is to find the minimum size of such a path partition. In general, this problem is NP-hard; however, there exist polynomial-time algorithms for certain graph classes. This talk will focus on characterization theorems for this problem that parallel some of the known algorithms. (Received July 05, 2012)

1082-05-157 **Trevor J. Gionet, Jr.** and **Erika L.C. King*** (eking@hws.edu), Department of Mathematics and Computer Sci., Hobart and William Smith Colleges, 300 Pulteney Street, Geneva, NY 14456, and **Yixiao Sha**. *Discovering the missing piece: 4-connected, 4-regular, claw-free graphs of odd order.*

In 1995, Michael D. Plummer published a paper in which he gave a characterization of the 4-regular, 4-connected, claw-free graphs. Based on that work, he and Bert Hartnell published a paper on 4-connected, claw-free, well-covered graphs a year later (a graph G is said to be *well-covered* if every maximal independent set of G is of the same size). While working on finding a shorter proof for a theorem King had proved several years before on characterizing 4-regular, claw-free, well-dominated graphs, Gionet and Sha unexpectedly discovered a graph that was inadvertently omitted from Plummer's characterization. This discovery led Gionet, King and Sha to fill in some missing pieces in previous results. In this talk, we will complete Plummer's characterization of all 4-connected, 4-regular, claw-free graphs, and then show the implications this has on the well-covered graphs he and Hartnell determined. In addition, we will characterize the 4-connected, 4-regular, claw-free, well-dominated graphs (a graph G is said to be *well-dominated* if every minimal dominating set of G is of the same size). (Received July 05, 2012)

1082-05-176 **Fidel Barrera-Cruz***, fbarrera@uwaterloo.ca, and **Penny Haxell**, pehaxell@math.uwaterloo.ca. *A Short Proof of Schnyder's Theorem.*

Given a graph $G = (V, E)$ we define its incidence poset $P = (V \cup E, <_G)$ where $x <_G y$ if and only if $x \in V$, $y \in E$ and x is an endpoint of y. W. Schnyder provided a characterization of planar graphs in terms of the dimension of their incidence poset. In his proof, Schnyder developed several concepts, such as *normal labellings, dual orders* and *tree decompositions*, which are by themselves very useful in the context of planar graphs. The purpose of this talk is to present a short and direct proof of Schnyder's result, that does not depend on these additional concepts. (Received July 06, 2012)

1082-05-186 **Andrew M. Baxter*** (baxter@math.psu.edu). *Enumeration schemes to count according to permutation statistics.* Preliminary report.

Let B be a set of vincular or barred patterns. An enumeration scheme for B encodes a polynomial-time algorithm which computes $|S_n(B)|$, where $S_n(B)$ is the set of permutations of length n avoiding B. The primary advantage of enumeration schemes is that they may be discovered via computer for many sets B. Thus they provide an easy first-line-of-attack to compute $|S_n(B)|$.

We will show how to find a scheme for set B which computes the number of permutations in $S_n(B)$ with k left-to-right minima. Similarly, one can count permutations in $S_n(B)$ according to the number of left-to-right

maxima, the number of copies of a given consecutive pattern, and the number of copies of a given vincular pattern of type $(m, 1)$. The schemes can also compute joint distributions of these statistics over $S_n(B)$.

We will also demonstrate applications of this method, finding generating functions for the total number of copies of consecutive patterns over $S_n(\{p\})$ for classical patterns p with length 3. (Received July 06, 2012)

1082-05-205 **Erik E Westlund*** (ewestlun@kennesaw.edu), Department of Mathematics and Statistics, Kennesaw State University, 1000 Chastain Road, Kennesaw, GA 30144. *Alspach's Conjecture: Hamilton decompositions of certain 6-regular Cayley graphs on Abelian groups of even order.*

Alspach conjectured that every connected $2k$-regular Cayley graph on a finite Abelian group A is Hamilton-decomposable. In this talk, we outline new progress on the conjecture for $k = 3$ when $|A|$ is even, and discuss some open problems. Liu has shown that for $|A|$ even, at least four, if $S = \{s_1, \ldots, s_k\} \subset A - \{0\}$ is inverse-free and a strongly minimal generating set of A (for all $s \in S$, we have $2s \notin \langle S \setminus \{s, -s\}\rangle$), then the Cayley graph, $\mathrm{Cay}(A; S^\star)$, is decomposable into k Hamilton cycles, where $S^\star$ denotes the inverse-closure of S. Extending these techniques, namely lifting Hamilton decompositions of quotient graphs to layered pseudo-cartesian products, we relax the constraint of strong minimality on S to requiring only that S be *strongly a-minimal*, for *some* $a \in S$ and the index of $\langle a\rangle$ be at least four. Strong a-minimality means that $2s \notin \langle a\rangle$ for all $s \in S \setminus \{a, -a\}$. This method allows us to settle some infinite families of open cases for the 6-regular Cayley graphs, $\mathrm{Cay}(A; \{s_1, s_2, s_3\}^\star)$, on even order Abelian groups. (Received July 08, 2012)

1082-05-207 **Catherine C. Erbes*** (catherine.erbes@ucdenver.edu), **Michael Ferrara**, **Ryan R. Martin** and **Paul Wenger**. *On the Shape of Degree Sequences that are Not Potentially H-graphic.*

A graphic sequence π is *potentially H-graphic* if there is a realization of π that contains H as a subgraph. Given graphic sequences $\pi_1 = (d_1, \ldots, d_n)$ and $\pi_2 = (s_1, \ldots, s_n)$, we say that π_1 *dominates* π_2 if $d_i \geq s_i$ for all i, $1 \leq i \leq n$. In 1970, Erdős showed that for any K_{r+1}-free graph H, there exists an r-partite graph G such that $\pi(G)$ dominates $\pi(H)$. In 2005, Pikhurko showed that for any graph F with chromatic number $r + 1$, the degree sequence of an F-free graph is nearly dominated by the degree sequence of an r-partite graph.

In this talk, we will discuss an analogue to these results for potentially H-graphic sequences. In particular, there is a graphic sequence $\pi^*(H)$ such that if π is a graphic sequence that is not potentially H-graphic, then π is close to being dominated by $\pi^*(H)$. Similar to the role played by complete multipartite graphs in the traditional extremal setting, the sequence $\pi^*(H)$ asymptotically gives the maximum possible sum of a graphic sequence π that is not potentially H-graphic. (Received July 08, 2012)

1082-05-211 **Adam S. Jobson**, **Andre E. Kezdy*** (kezdy@louisville.edu) and **Susan C. White**. *Totally Balanced Hypergraphs Revisited.*

A hypergraph is *totally balanced* if every cycle of length greater than two has an edge containing at least three vertices of the cycle. These hypergraphs arise naturally in many applications as they are closely connected to the standard greedy form of binary matrices. In 1983, Anstee discovered a remarkable 'overlay' structure of these hypergraphs and, two years later, Lehel revealed that this structure can be viewed as a 'tree-sequence' construction. We revisit these results, proving uniqueness and simplifying the algorithms to construct this tree sequence. If time permits, algorithmic applications will also be presented. (Received July 08, 2012)

1082-05-230 **Michael Dairyko** and **Lara Pudwell*** (lara.pudwell@valpo.edu), Department of Mathematics & Computer Science, 1900 Chapel Drive, Valparaiso, IN 46383, and **Samantha Tyner** and **Casey Wynn**. *Non-contiguous pattern avoidance in binary trees.*

In 2010, Rowland considered pattern avoidance in rooted ordered binary trees with the following definition: binary tree T contains binary tree t if and only if T contains t as a contiguous rooted ordered subgraph. We modify Rowland's definition such that binary tree T contains tree t if and only if there is a sequence of edge contractions of T that produce tree T* which contains t as a rooted ordered subgraph. While Rowland's tree patterns are analogous to consecutive permutation patterns, this new definition is analogous to classical permutation patterns. We completely classify Wilf classes of trees avoiding a single non-contiguous binary tree pattern and provide generating functions that enumerate pattern-avoiding trees according to number of leaves. We also provide bijective relationships between certain sets of pattern-avoiding trees and sets of pattern-avoiding permutations.

Based on joint work with Mike Dairyko (Pomona College), Samantha Tyner (Iowa State University), and Casey Wynn (Kent State University). (Received July 09, 2012)

1082-05-241 **Bryan Ek***, School of Mathematical Sciences, 85 Lomb Memorial Drive, Rochester Institute of Technology, Rochester, NY 14623-5604, **Caitlin VerSchneider**, Department of Mathematics, Nazareth College, Rochester, NY , and **Darren A. Narayan**, School of Mathematical Sciences, 85 Lomb Memorial Drive, Rochester Institute of Technology, Rochester, NY 14623-5604. *Efficiency of star-like graphs and the Atlanta Subway network.*

The distance between any two vertices u and v in a graph is the number of edges in a shortest path between u and v. If there is no path connecting u and v, then the distance between u and v is said to be infinity. In 2001, Latora and Marchiori introduced the measure of efficiency between vertices in a graph. The efficiency between two vertices i and j is defined as the inverse of the corresponding distance. The global efficiency of a graph is the average of the efficiencies over all pairs of distinct vertices. We investigate the global efficiency of star-like networks, and show that networks of this type are very efficient. In particular we analyze the Metropolitan Atlanta Rapid Transit Authority (MARTA) Subway system, and show this network is 82 percent as efficient as a network where there is a direct line between every pair of stations. (Received July 09, 2012)

1082-05-244 **Bryan Ek**, School of Mathematical Sciences, 85 Lomb Memorial Drive, Rochester Institute of Technology, Rochester, NY 14623-5604, **Caitlin VerSchneider**, Department of Mathematics, Nazareth College, Rochester, NY 14618, and **Darren A. Narayan***, School of Mathematical Sciences, 85 Lomb Memorial Drive, Rochester Institute of Technology, Rochester, NY 14623-5604. *Efficiency of Graphs.*

The distance between any two vertices u and v in a graph is the number of edges in a shortest path between u and v. If there is no path connecting u and v, then the distance between u and v is said to be infinity. In 2001, Latora and Marchiori introduced the measure of efficiency between vertices in a graph. The efficiency between two vertices i and j is defined as the inverse of the corresponding distance. The global efficiency of a graph is the average of the efficiencies over all pairs of distinct vertices. We determine global efficiencies for many families of graphs including: powers of paths and cycles, complete multipartite graphs, and various Cartesian products of graphs. We also consider two other measures of efficiency and connectivity. Given a graph G, let G_i denote the subgraph induced by the neighbors of vertex v_i. Then the local efficiency of G is the average of the global efficiencies of the subgraphs G_i. Also the clustering coefficient is the average number of edges in the sugraphs C_i. We present familes of graphs where the local efficiency and clustering coefficient are the same and others where they are very different. (Received July 09, 2012)

1082-05-248 **Jeremy Lyle*** (samuel.lyle@usm.edu). *Independent Sets in Dense Graphs with Small Cliques.*

Graphs with large minimum degree containing no copy of a clique on r vertices (K_r) must contain relatively large independent sets. A classical result of Andrásfai, Erdős, and Sós implies that K_r-free graphs G with degree larger than $((3r-7)/(3r-4))|V(G)|$ must be $(r-1)$-partite. An obvious consequence of this result is that the same degree threshold implies an independent set of order $(1/(r-1))|V(G)|$. In this talk, we consider the problem of determining better bounds on the minimum degree which would imply the same conclusion. This problem was first considered by Brandt, and we provide improvements for $r > 5$. (Received July 09, 2012)

1082-05-250 **Eric S. Egge***, Department of Mathematics, Carleton College, Northfield, MN 55057. *Some New Pattern-Avoiding Permutations Counted by the Schroder Numbers.* Preliminary report.

In 2000 Kremer classified all pairs π_1,π_2 of permutations of length 4 for which $|S_n(\pi_1, \pi_2)| = r_{n-1}$, where r_n is the nth Schröder number. Numerical evidence suggests there are several permutations σ of length 6 such that $|S_n(2413, 2143, \sigma)| = r_{n-1}$ as well. In this talk I will discuss recent progress toward a proof these conjectures. (Received July 09, 2012)

1082-05-255 **Jonathan Cutler*** (jonathan.cutler@montclair.edu) and **A. J. Radcliffe**. *Hypergraph independent sets.*

Starting with the result of Kahn giving an upper bound on the number of independent sets in regular bipartite graphs, the last decade has seen many results related to the enumeration of independent sets in various classes of graphs. For example, it has been observed that the Kruskal-Katona theorem implies that the maximum number of independent sets in graphs of fixed order and size is obtained by the lex graph, where edges form an initial segment according to the lexicographic order. A natural question arises when trying to extend this result to hypergraphs, but hypergraphs have different types of independent sets. We call a set of vertices in an r-uniform hypergraph *j-independent* if its intersection with any edge has size strictly less than j. The Kruskal-Katona theorem implies that among r-uniform hypergraphs of fixed order and size, the hypergraph with the most r-independent sets is the lexicograph hypergraph. In this talk, we present a result that uses a technique of Loh,

Pikhurko, and Sudakov and a hypergraph regularity lemma to give an asymptotically best possible bound on the number of j-independent sets in an r-uniform hypergraph. (Received July 09, 2012)

1082-05-259 **Jonelle Hook*** (jhook@msmary.edu), 16300 Old Emmitsburg Rd, Emmitsburg, MD 21727. *On star-critical Ramsey numbers.*

The *graph Ramsey number* $R(G,H)$ is the smallest integer r such that every 2-coloring of the edges of K_r contains either a red copy of G or a blue copy of H. We find the largest star that can be removed from K_r such that the resulting graph must still contain a red G or a blue H. Thus, the *star-critical Ramsey number* $r_*(G,H)$ is the smallest integer k such that every 2-coloring of the edges of $K_r - K_{1,r-1-k}$ contains either a red G or a blue H. We will discuss various star-critical Ramsey numbers with a focus on $r_*(P_n, P_m)$. In addition, we will classify the critical graphs for the path-path Ramsey number. Additional results for various classes of graphs will be summarized. (Received July 09, 2012)

1082-05-265 **Hehui Wu*** (hehui.wu@mcgill.ca) and **Mohit Singh**. *Integrality gap for Demand Matching Problem and fractional coloring number for tree-nets.*

Given a simple bipartite graph $G = (V, E)$, a demand function d and a profit function π on edges and a capacity function b on vertices. A subset M of edges is called a demand matching if the sum of demands d_e of edges chosen in M incident at v is at most b_v for each vertex v. The goal of the demand matching problem is to select a demand matching M which maximizes the sum of profit of edges in M. When all demands $d_e = 1$, this problem is exactly the b-matching problem.

In this paper we give nearly tight upper and lower bounds on the integrality gap of a natural linear programming relaxation for the problem. Our first result is to show that the integrality gap is bounded from above by the fractional coloring number of a *tree-net*. A tree-net is a graph obtained by connecting non-adjacent vertices of a tree by vertex disjoint paths of length at least two. We then give an explicit bound of 2.708 on the fractional chromatic number of any tree-net which also results in a 2.708-approximation algorithm. To complement this algorithm, we explicitly show a lower bound of 2.699 on the integrality gap by constructing tree-net graphs whose fractional chromatic number is at least 2.699. (Received July 09, 2012)

1082-05-266 **Brian Nakamura***, bnaka@math.rutgers.edu, and **Doron Zeilberger**. *Counting permutations with exactly r occurrences of the pattern* 123. Preliminary report.

We will consider the problem of enumerating permutations that contain exactly r occurrences of the pattern 123. Previous work by Noonan and Zeilberger considered this problem and gave a concrete method of enumeration for $r \leq 2$. We will discuss an alternate approach using functional equations to enumerate such permutations. This new approach also works for larger r values, and in some instances, we can also (rigorously) prove closed form formulas.

(Joint work with D. Zeilberger) (Received July 09, 2012)

1082-05-268 **Linyuan Lu** and **Kevin G Milans*** (milans@math.sc.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. 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 July 09, 2012)

1082-05-275 **Peter Kosek*** (kosek.3@buckeyemail.osu.edu), 58 E. 11th Avenue, Apartment 16, Columbus, OH 43201. *Extremal Graphs Without 4-Cycles.*

Determining the largest number of edges in a C_4-free graph on n vertices is a problem that remains unsolved for general n. However, we extended previous work by Füredi to prove an upper bound for the number of edges in a C_4-free graph on $q^2 + q$ vertices for q even. This upper bound is achieved if and only if there is an orthogonal polarity graph of a projective plane of even order q. (Received July 09, 2012)

1082-05-283 **Christopher R. H. Hanusa** and **Brant Jones*** (jones3bc@jmu.edu). *Abacus models in affine Weyl groups.*

We introduce abacus diagrams that describe minimal length coset representatives in affine Weyl groups of types B, C, and D. These diagrams generalize a construction of James for the symmetric group, and can be used to enumerate generalized core partitions and affine permutations. (Received July 10, 2012)

1082-05-294 **Fan Chung** and **Paul Horn*** (phorn@math.harvard.edu), Department of Mathematics, FAS, Harvard University, One Oxford Street, Cambridge, MA 02138, and **Jacob Hughes**. *Commodity distribution on graphs and Kronecker PageRank.*

Demand for a number of commodities spreads through a graph. As a supplier on a budget, we wish to schedule shipments of these commodities to vertices to ensure that demands are eventually satisfied without wasting our goods. In this talk, we study a model of demand spread based on the classical contact process, which is a model of the spread of disease. Our model allows demand for different commodities to influence each other. We link the evolution of the process to PageRank of the graph, and a new parameter Kronecker PageRank which captures geometric information about both the underlying graph and the spreading process. In particular, we show that the probability that demand 'escapes' a subset of the graph can be bounded in terms of both PageRank and, more sharply, by Kronecker PageRank. This gives a way to choose a set of vertices to make shipments to along with appropriate shipment rates, and gives a performance guarantee on our strategy. (Received July 10, 2012)

1082-05-298 **Alexandr V Kostochka** and **Christopher J Stocker*** (christopher.stocker@wku.edu), Department MSCS Cudahy Hall, Marquette University, P.O. Box 1881, Milwaukee, WI 53201, and **Paul Wrayno**. *Star colorings and acyclic colorings of graphs with bounded degree.* Preliminary report.

A star coloring is a proper coloring with no induced P_4. An acyclic coloring is a proper coloring with the additional property that any two color classes induce a forest. In this talk, we consider bounds on these coloring parameters which arise when we fix a maximum degree.

In 1973 Grünbaum conjectured that for every r, each graph G with $\Delta(G) \leq r$ has an acyclic $(r+1)$-coloring. The conjecture is known to be true for $r \leq 4$ and false for large values of r. We show that for $r = 5$, 7 colors suffice and give a new bound for general r. We also give a new bound on the star chromatic number for general r. This is based on work with Alexandr V. Kostochka and work with Paul Wrayno. (Received July 10, 2012)

1082-05-299 **Kathleen M Ryan***, 14 East Packer Avenue, Bethlehem, PA 18015, and **Garth Isaak**. *Factors and 2-Edge-Colorings of Graphs of Specified Families.*

Given a graph with max degree Δ, we define a $[d_0, d_1, \cdots, d_\Delta]$-*factor* of the graph to be a spanning subgraph containing d_i vertices of degree i, respectively, for $0 \leq i \leq \Delta$. We consider whether or not a graph G has a $[d_0, d_1, \cdots, d_\Delta]$-*factor* when G is known to be of a special family, such as grids, disjoint unions of paths, or disjoint unions of cycles. Due to a natural relationship between factors of graphs and edge-colorings of graphs with 2 colors, we describe how the factor results give insight into the following question: Given a graph family $\mathcal{F}$ such as those previously listed, when does there exist some graph in $\mathcal{F}$ which can be edge-colored so as to realize a given set of degree vectors? (Received July 10, 2012)

1082-05-300 **Nathan Kahl***, Seton Hall University, Dept. of Mathematics and Computer Science, 400 S. Orange Ave., South Orange, NJ 07079. *Toughness and Binding Number.* Preliminary report.

Let $\tau(G)$ and $\text{bind}(G)$ be the toughness and binding number, respectively, of a graph G. In his paper introducing binding number Woodall observed 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 July 10, 2012)

1082-05-303 **Daniel A. Daly*** (ddaly@semo.edu) and **Lara K. Pudwell**. *Pattern Avoidance in Rook Monoids.* Preliminary report.

The rook monoid, R_n on $\{0, 1, \ldots, n\}$ is the set of all 0-1 matrices that contain at most one 1 in every row and column. As such rook monoids are generalizations of permutations. In this talk we will discuss generalizing the notion of pattern avoidance to rook monoids and the enumeration results that follow. (Received July 10, 2012)

1082-05-306 **Paul E Becker*** (peb8@psu.edu), **Sheridan Houghten**, **Martin Derka** and **Jennifer Ulrich**. *A Simple Construction for the Extended Golay Code.*

The extended Golay code stores information as vectors of length 24 in a 12-dimensional self-dual binary vector space. It is extremal, meaning that the minimum separation between codewords is as large as possible. For this reason, the code has useful error-correcting properties. Many constructions of the extended Golay code are known. We present what we believe to be a new, and surprisingly simple, construction. A generating matrix for the code can be formed by direct subsitutions into the standard generating matrix for the Hamming code of length 8. The resulting matrix is highly symmetric, and helps to explain the Golay code's extremely large automorphism group. (Received July 10, 2012)

1082-05-318 **Alexander Burstein*** (aburstein@howard.edu), Department of Mathematics, Howard University, Washington, DC 20059. *A combinatorial proof of equidistribution of certain Euler-Mahonian statistics.* Preliminary report.

We give a direct combinatorial proof of the joint equidistribution of two pairs of permutation statistics, (aid, des) and (inv, lec), which have been previously shown to have the same joint distribution as (maj, exc), the pair of the major index and the number of excedances of a permutation. Moreover, the triple (inv, lec, pix) was shown to have the same distribution as (maj, exc, fix), where fix is the number of fixed points of a permutation. We define a new statistic aix so that our bijection maps (inv, lec, pix) to (aid, des, aix). (Received July 10, 2012)

1082-05-327 **Nathan Reff***, Division of Mathematics, Alfred University, Alfred, NY 14802. *Spectral Properties of Oriented Hypergraphs.* Preliminary report.

An oriented hypergraph is a hypergraph where each vertex-edge incidence is given a label of +1 or -1. This incidence structure can be viewed as a hypergraphic generalization of a signed graph. We study the adjacency and Laplacian eigenvalues of an oriented hypergraph. We find eigenvalue bounds which depend on structural parameters of the oriented hypergraph. We also study a family of oriented hypergraphs that provide a hypergraphic version of the signless Laplacian matrix. (Received July 10, 2012)

11 ► Number theory

1082-11-1 **Steven M. Gonek*** (gonek@math.rochester.edu), Department of Mathematics, University of Rochester, Rochester, NY 14627. *Whither the Riemann zeta function?*

The last forty years have seen remarkable advances in our understanding of the Riemann zeta function. For example, we now have precise conjectural answers to some of the most important classical questions about the zeta function, questions that had once seemed intractable. In this expository talk I will give a motivated overview of the main currents of the classical and modern theory of the zeta function and describe a number of these advances. (Received July 09, 2012)

1082-11-43 **Maksym Radziwill*** (maksym@stanford.edu), Department of Mathematics, Stanford University, 450 Serra Mall, Bldg. 380, Stanford, CA 94305. *Limitations to mollifying $\zeta(s)$.*

We establish limitations to how well one can mollify the Riemann zeta function on the critical line, with mollifiers of arbitrary length. Our result gives a non-trivial lower bound for the contribution of the off-diagonal terms to mollified moments of zeta. On the Riemann Hypothesis, we establish a connection between the mollified moment and Montgomery's Pair Correlation Function. (Received June 06, 2012)

1082-11-48 **Angel V Kumchev***, Department of Mathematics, Towson University, Towson, MD 21252. *New results in the Waring-Goldbach problem.* Preliminary report.

A recent breakthrough by T.D. Wooley in the study of Vinogradov's mean-value integral has led to improved bounds for Weyl sums over primes. In this talk, I will announce some applications of the new bounds to the Waring-Goldbach problem in nine or more variables. (Received June 11, 2012)

1082-11-56 **Yoonbok Lee*** (lee@math.rochester.edu), Department of Mathematics, University of Rochester, Rochester, NY 14627. *Zeros of partial zeta functions off the critical line.*

We extend the joint universality theorem for Artin L-functions $L(s, \chi_j, K/\mathbb{Q})$ from the previously known strip $1 - 1/(2k) < \Re\, s < 1$ for $k = |G(K/\mathbb{Q})|$ to the maximal strip $1/2 < \Re\, s < 1$ under an assumption of a version of the density hypothesis. As a consequence we study zeros of partial zeta functions $\zeta(s, A)$ inside the strip $1/2 < \Re\, s < 1$. (Received June 12, 2012)

1082-11-59 **Robert Charles Vaughan***, rvaughan@math.psu.edu, and **William Banks** and **Ahmet Muhtar Guloglu**. *A very general form of the local to global principle.*

A very general form of the local to global principle is established and applied to a variety of additive questions. (Received June 17, 2012)

1082-11-73 **Lola Thompson*** (lola.thompson@oberlin.edu). *On the degrees of divisors of $x^n - 1$.*

Fix a field F and let n be a positive integer. In this talk, we examine the question "How often does the polynomial $x^n - 1$ have a divisor of every degree between 1 and n in $F[x]$?" We also ask: "For how many $n \leq X$ does $x^n - 1$ have a divisor in $F[x]$ of a given degree?" We prove bounds in these problems for both $F = \mathbb{Q}$ and $F = \mathbb{F}_p$ (with p prime), the latter conditional on the Generalized Riemann Hypothesis. This talk is based on joint work with Paul Pollack. (Received June 22, 2012)

1082-11-76 **Michael Filaseta*** (filaseta@math.sc.edu), Department of Mathematics, Columbia, SC 29208, and **Samuel Gross** (ssgross@math.sc.edu). *49598666989151226098104244512918 and 859244474352913581576954595536773.* Preliminary report.

The numbers in the title are the first two terms of a sequence. We know the sequence has at least three terms, but do not know the third term or whether the sequence is infinite. If p is a prime with decimal representation $d_n d_{n-1} \dots d_1 d_0$, then Cohn's theorem states that the polynomial $f(x) = d_n x^n + d_{n-1} x^{n-1} + \cdots + d_1 x + d_0$ is irreducible over the rationals. The decimal representation of a number that is not prime, notably 5^k and 16^k for an arbitrary positive integer k and $2p$ where p is a prime, can also lead to an irreducible polynomial. But what does this have to do with the numbers in our title? In this talk, we shall reveal the mystery behind these numbers and their connection to Cohn's theorem. A variety of open problems will be presented. (Received June 24, 2012)

1082-11-82 **Hugh L Montgomery*** (hlm@umich.edu), Department of Mathematics, University of Michigan, 530 Church Street, Ann Arbor, MI 48109-1043, and **Steven M. Gonek** (gonek@math.rochester.edu), Department of Mathematics, University of Rochester, P.O. Box 270138, Rochester, NY 14627. *Large values of the zeta function at critical points.*

It is classical that $\zeta(1+it)$ is as large as $e^{C_0} \log\log t$ for arbitrarily large t. We consider large values of the zeta function at critical points $s = \sigma + it$ with $\sigma > 1$. We find that the same order of magnitude can be achieved, but with a smaller constant. (Received June 25, 2012)

1082-11-85 **John B Friedlander*** (frdlndr@math.toronto.edu), Dept. of Mathematics, University of Toronto, 40 St. George Street, Toronto, Ontario M5S 2E4, Canada. *Semi-Linear Sieve, Ternary Quadratic Forms and the Enumeration of Certain Varieties.*

In joint work with Igor Shparlinski we consider the problem of counting the number of representations of a large positive integer as the sum of a square and an integer all of whose prime factors are from a set of primes of density one half.

We confine ourselves to the special case which motivated our work by having an application to the enumeration of certain varieties over a finite field. (Received June 27, 2012)

1082-11-88 **Sidney W. Graham*** (graha1sw@cmich.edu), Department of Mathematics, 1501 S Washington St, Central Michigan University, Mt. Pleasant, MI 48859-0001. *The Ideal Sieve In Dimension ≤ 1.* Preliminary report.

We consider a simplified sieving problem in which all the sifting primes p lie in an interval I of the form $z^{1/(R+1)} \leq p \leq z^{1/R}$. We also assume that the dimension of the sieve is ≤ 1. In other words, if $g(p)$ is the sieving density for p, then $\sum_{p \in I} g(p) \leq 1$. Under these conditions, we can construct upper and lower bound sieves, and we can construct examples to show that these bounds are optimal.

This is joint work with Hugh Montgomery. (Received June 27, 2012)

1082-11-113 **Leo Goldmakher***, Department of Mathematics, University of Toronto, and **Youness Lamzouri**, Department of Mathematics and Statistics, York University. *Large character sums.*

In 1932, Paley constructed an infinite family of quadratic characters whose character sums attain a large magnitude. Under the assumption of the Generalized Riemann Hypothesis, conditional analogues of Paley's result were obtained by Granville and Soundararajan for characters of any even order, and by the presenter for characters of any odd order; in both cases, the bounds were (conditionally) optimal. I will discuss recent work (joint with Youness Lamzouri) in which we recover the same omega results for characters of any fixed order, unconditionally. (Received July 01, 2012)

1082-11-121 **Stephen J. Lester*** (lester@math.rochester.edu). *a-Points of the Riemann zeta-function on the critical line.*

The roots of $\zeta(s) = a$, where a is a nonzero complex number are known as a-points and have long been an object of study in the theory of the Riemann zeta-function. In this talk we will briefly describe some of their properties and discuss the problem of determining how many a-points lie on the line $\Re(s) = 1/2$. (Received July 02, 2012)

1082-11-123 **Jing-Jing Huang*** (constantinejing@gmail.com) and **Robert Vaughan**. *Sums of unit fractions.*

The results presented in this talk are joint work of Robert Vaughan with myself. We are mainly concerned with the Diophantine equation

$$\frac{a}{n} = \frac{1}{x_1} + \frac{1}{x_2} + \cdots + \frac{1}{x_k}$$

and its number of positive integer solutions $R_k(n;a)$. We begin with the binary case $k=2$. Now the distribution of the function $R_2(n;a)$ is well understood. More precisely, by averaging over n, the first moment and second moment behaviors of $R_2(n;a)$ have been established. For instance, one of our results is

$$\sum_{\substack{n\le N\\(n,a)=1}} R_2(n;a) = NP_2(\log N;a) + O_a(N\log^5 N),$$

where $P_2(\cdot;a)$ is a quadratic function whose coefficients depend on a. Furthermore, we have shown that, after normalisation, $R_2(n;a)$ admits Gaussian distribution, which is an analog of the classical theorem of Erdős and Kac.

On the other hand, let $E_a(N)$ denote the number of $n\le N$ such that $R_2(n;a)=0$. It is established that when $a\ge 3$ we have

$$E_a(N) \sim C(a)\frac{N(\log\log N)^{2^{m-1}-1}}{(\log N)^{1-1/2^m}},$$

with m defined in the talk.

The next project would be to study the ternary case $k=3$. Results on the mean value $\sum_{n\le N} R_3(n;a)$ will be discussed if time permits. (Received July 02, 2012)

1082-11-133 **Youness Lamzouri*** (youness.lamzouri@gmail.com), Department of Mathematics and Statistics, York University, 4700 Keele St, Toronto, ON M3J 1P3, Canada. *Discrepancy bounds for the distribution of the Riemann zeta function.*

In 1930 Bohr and Jessen proved that for any $1/2<\sigma\le 1$, $\log\zeta(\sigma+it)$ has a continuous limiting distribution in the complex plane. As a consequence they deduced that the set of values of $\log\zeta(\sigma+it)$ is everywhere dense in $\mathbb{C}$. Harman and Matsumoto obtained a quantitative version of the Bohr-Jessen Theorem using Fourier analysis on a multidimensional torus. In this talk we shall present a different and more direct approach which leads to uniform discrepancy bounds for the distribution of $\log\zeta(\sigma+it)$ that improve the Matsumoto-Harman estimates. (Received July 03, 2012)

1082-11-138 **Brandt Kronholm*** (jkronhol@whittier.edu). *Several Results on Ramanujan Congruence Properties of the Restricted Partition Function $p(n,m)$.*

$p(n,m)$ is the restricted partition function that enumerates the number of partitions of n into exactly m parts. Recent and ongoing investigation of Ramanujan congruence properties of $p(n,m)$ has yielded patterns having a tremendous amount of symmetry and balance. Here are several specific examples:

$$p(2940j,7)\equiv p(2940j-7,7)\equiv p(2940j-14,7)\equiv 0 \pmod{7^2}$$
$$p(27720k+27698,11)\equiv 0 \pmod{1815}.$$

$$\begin{aligned}
p(60k+55,5)+p(60k+65,5) &\equiv p(0) \equiv 1 \pmod 5\\
p(60k+54,5)+p(60k+66,5) &\equiv p(1) \equiv 1 \pmod 5\\
p(60k+53,5)+p(60k+67,5) &\equiv p(2) \equiv 2 \pmod 5\\
p(60k+52,5)+p(60k+68,5) &\equiv p(3) \equiv 3 \pmod 5
\end{aligned}$$

The aim of this presentation is to discuss generalizations of the above examples and methods of proof using $q-$series. We will pay particular attention to generalizations and open questions regarding last four examples. (Received July 03, 2012)

1082-11-152 **Scott T. Parsell*** (sparsell@wcupa.edu), **Sean M. Prendiville** and **Trevor D. Wooley**. *Mean value estimates for translation-invariant systems.*

We investigate generalizations of Vinogradov's mean value theorem for arbitrary translation-dilation invariant systems, in which the seed polynomials may depend on more than one variable. By extending Wooley's efficient congruencing method to this multidimensional setting, we obtain sharp estimates for mean values in which the number of variable blocks required is within a constant factor of best possible. We mention several concrete examples of systems to which our new bounds apply and discuss some consequences for associated Diophantine problems. (Received July 05, 2012)

1082-11-159 **Micah B. Milinovich*** (mbmilino@olemiss.edu), Department of Mathematics, University of Mississippi, University, MS 38677. *The size of $S(t)$ in the theory of the Riemann zeta-function.*

Let $\pi S(t)$ denote the argument of the Riemann zeta-function, $\zeta(s)$, at the point $s = 1/2 + it$. I will discuss how to sharpen some of the classical estimates for $S(t)$ under the assumption of the Riemann Hypothesis. (Received July 05, 2012)

1082-11-163 **Michael Rubinstein*** (michael.o.rubinstein@gmail.com), Pure Math, UW, 200 University Ave W, Waterloo, ON N2L3G1, Canada. *Identities for L-functions.*

I describe a variety of new identities for the Riemann zeta function, Hurwitz zeta function, and Dirichlet L-functions. These have application to high precision computation and special values. (Received July 05, 2012)

1082-11-166 **Michael J. Mossinghoff*** (mimossinghoff@davidson.edu), Davidson College, Davidson, NC 28035-6996, and **Timothy S. Trudgian** (timothy.trudgian@anu.edu.au), Australian National University, Canberra, Australia. *Between the problems of Pólya and Turán.*

We investigate the behavior of the function $L_\alpha(x) = \sum_{n \le x} \lambda(n)/n^\alpha$, where $\lambda(n)$ is the Liouville function and α is a real parameter. The case $\alpha = 0$ was investigated by Pólya; the case $\alpha = 1$, by Turán. The question of the existence of sign changes in both $L_0(x)$ and $L_1(x)$ is related to the Riemann hypothesis. We investigate similar questions for $L_\alpha(x)$ with $0 \le \alpha \le 1$, and their connections to the Riemann hypothesis and other properties of the zeros of the Riemann zeta function. (Received July 05, 2012)

1082-11-172 **Michael P. Knapp*** (mpknapp@loyola.edu). *A formula for the function $\Gamma_2^*(d)$.* Preliminary report.

For a positive integer d, we define the number $\Gamma_2^*(d)$ to be the smallest integer s such that any equation of the form

$$a_1 x_1^d + a_2 x_2^d + \cdots + a_s x_s^d = 0$$

with integer coefficients has nontrivial 2-adic solutions. In this talk, we will give an explicit formula for $\Gamma_2^*(d)$. (Received July 06, 2012)

1082-11-173 **Gang Yu*** (yu@math.kent.edu), Department of Mathematical Sciences, Kent State University, Summit St, Kent, OH 44242. *Some remarks on L^1-norm of Littlewood polynomials and Barker sequences.* Preliminary report.

$f(x) = \sum_{i=0}^{n-1} \epsilon_i x^i$ is called a Littlewood polynomial if $\epsilon_i \in \{\pm 1\}$. A Barker sequence is a ± 1 sequence $\mathcal{S}_n = \{\epsilon_i : 0 \le i \le n-1\}$ such that, for every $j \ne 0$, its autocorrelation $c_j = \sum_{0 \le k, k+j \le n-1} \epsilon_k \epsilon_{k+j}$ is equal to $-1, 0$, or 1. It is conjectured that there are only finitely many Barker sequences, and this conjecture is equivalent to a certain estimate for the L^1-norm of the corresponding Littlewood polynomial on the unit circle. In this talk, I will give some remarks on Barker sequences and estimation of the L^1-norm of Littlewood polynomials. (Received July 06, 2012)

1082-11-179 **Daniel A. Goldston** (daniel.goldston@sjsu.edu), Department of Mathematics, San José State University, 315 MacQuarrie Hall, One Washington Square, San Jose, CA 95192-0103, and **Andrew H. Ledoan*** (andrew-ledoan@utc.edu), Department of Mathematics, University of Tennessee at Chattanooga, 417F EMCS Building, 615 McCallie Avenue, Chattanooga, TN 37403-2598. *On the differences between consecutive prime numbers, II.* Preliminary report.

In 1976, Gallagher proved that the Hardy-Littlewood prime k-tuple conjecture implies that, for the primes up to x, the number of primes in the interval $(x, x+\lambda \log x]$, for any fixed positive constant λ, has a Poisson distribution. Using inclusion-exclusion, we recently showed that the number of consecutive primes with difference $\lambda \log x$ has the Poisson distribution superimposed on the conjectured formula for pairs of primes with this difference. In this talk, we will present more precise formulas if $\lambda \to 0$ as $x \to \infty$. In order to obtain these formulas, it is necessary to prove some new singular series average results. (This is based on a joint work with Professor Daniel. A. Goldston at San José State University.) (Received July 06, 2012)

1082-11-206 **Ben Sokolowsky**, **Amy VanHooft*** (avanh1@brockport.edu), **Rachel Volkert** and **Cliff Reiter**. *Infinite Families of Perfect Parallelepipeds Exist.* Preliminary report.

A perfect parallelepiped is such that the edges, face diagonals, and body diagonals of the shape are all of integer length. The first example of a perfect parallelepiped was discovered in 2009 by Jorge Sawyer and Cliff Reiter. The initial discovery of these shapes produced a limited list of specific examples of perfect parallelepipeds which had no linking factor between them and no insight as to whether or not infinitely many distinct examples exist.

In this talk we will discuss the process through which it has been recently proved that infinite families of distinct perfect parallelepipeds exist. We will also discuss the implications which these newly parameterized families have on the famous open problem concerning the existence of a perfect cuboid. (Received July 08, 2012)

1082-11-213 **J Brian Conrey***, 360 Portage Ave, Palo Alto, CA 94306. *Zeros of period polynomials.* We show that apart from 5 "trivial" zeros, all of the zeros of a period polynomial associated with a cusp form of level one are on the unit circle. This work is joint with David Farmer and Ozlem Imamoglu. (Received July 08, 2012)

15 ► Linear and multilinear algebra; matrix theory

1082-15-79 **Steven J Miller*** (sjm1@williams.edu), 18 HOXSEY ST, WILLIAMSTOWN, MA 01267, and **Rachel Insoft** (rinsoft@wellesley.edu) and **Philip Tosteson** (Philip.D.Tosteson@williams.edu). *Cookie Monster Meets the Fibonacci Numbers. Mmmmmm – Theorems!*

A beautiful theorem of Zeckendorf states that every positive integer can be written uniquely as a sum of non-consecutive Fibonacci numbers. Once this has been shown, it's natural to ask how many Fibonacci numbers are needed. Lekkerkerker proved that the average number of such summands needed for integers in $[F_n, F_{n+1})$ is $n/(\phi^2+1)$, where ϕ is the golden mean. We present a combinatorial proof of this through the cookie problem and differentiating identities, and further prove that the fluctuations about the mean are normally distributed. These techniques apply to numerous generalizations, such as signed decompositions as well as allowing for repeated summands which destroys uniqueness of decomposition, which we'll discuss as time permits. (Received June 25, 2012)

1082-15-236 **Yong Wang**, **Dong Liang** (lei_faith_00@yahoo.com) and **Leslie Ying*** (leiying@buffalo.edu), 223 Davis Hall, Buffalo, NY 14260. *A Novel L0-L1 Hybrid Norm Minimization Algorithm for Compressed Sensing Reconstruction.*

In compressed sensing reconstruction, it is known that L_1 minimization algorithms require more measurements than L_0 ones do. On the other hand, the homotopic L_0 minimization algorithms are usually more sensitive to noise and errors than L_1 ones are. In this work, we present a hybrid norm which effectively integrates both L_1 and L_0-norms by introducing a smooth transition at a threshold. The hybrid-norm minimization algorithm has the benefits of both the robustness of L_1 and reduced measurements of homotopic L_0. Simulations demonstrate the proposed method outperforms the L_1 and homotopic L_0 minimization algorithms in reconstructing magnetic resonance images. (Received July 09, 2012)

16 ► Associative rings and algebras

1082-16-145 **Sean I. Clark*** (sic5ag@virginia.edu), **Weiqiang Wang** and **David Hill**. *Towards canonical bases for quantum Kac-Moody superalgebras.* Preliminary report.

In this talk, we will briefly discuss the construction of the canonical basis of $\mathfrak{osp}(1|2)$ and explain how this motivates a new definition of quantum Kac-Moody superalgebras. Then we will discuss recent joint work with Hill and Wang towards a general approach to constructing canonical bases for Kac-Moody superalgebras. (Received July 04, 2012)

1082-16-198 **Alexander P Ellis*** (ellis@math.columbia.edu), **Mikhail Khovanov** and **Aaron Lauda**. *Odd symmetric functions and odd categorified quantum sl(2).*

We introduce odd analogues of the symmetric functions, the nilHecke algebra, and the cohomology of Grassmannians. These algebras are used in constructing an odd categorification of quantum sl(2) and, conjecturally, odd Khovanov homology. (Received July 07, 2012)

1082-16-232 **Zhaobing Fan*** (fanz@math.ksu.edu), 1545 International Court, M24, Manhattan, KS 66502, and **Yiqiang Li**. *Monomial basis and PBW basis arising from stability conditions.* Preliminary report.

Abstract: There exist some algebraic generators of U_q^+ corresponding to certain quivers of type A_n. The ordered multiplication of these algebraic generators will give a PBW basis of U_q^+, where the order is given by the slope of some stability conditions. Moreover, the stability condition can be used to construct a monomial basis. This is joint work with Yiqiang Li. (Received July 09, 2012)

1082-16-247 **Joshua Sussan*** (joshuasussan@gmail.com). *Braid group actions and Heisenberg categorification.*

Associated to a simply laced Dynkin diagram there is a corresponding affine Lie algebra and a Heisenberg subalgebra. On the Fock space representation of this Heisenberg algebra we construct an action of a braid group. We also categorify this action by constructing functors on a certain category of modules and show that these functors satisfy the braid group relations. This is joint work with S. Cautis and A. Licata. (Received July 09, 2012)

1082-16-282 **David Hill*** (deh4n@virginia.edu) and **Weiqiang Wang**. *Categorification and Canonical Bases of Kac-Moody Superalgebras.*

In a recent work with Wang, we obtained a Categorification of Kac-Moody Superalgebras using the spin quiver Hecke algebras defined by Kang-Kashiwara-Tsuchioka. This leads to a canonical basis given by projective indecomposables. We are therefore motivated to search for an algebraically defined canonical basis. Joint with Sean Clark and Weiqiang Wang. (Received July 10, 2012)

17 ► Nonassociative rings and algebras

1082-17-84 **Seok-Jin Kang**, **Kyu-Hwan Lee*** (khlee@math.uconn.edu), **Hansol Ryu** and **Ben Salisbury**. *A combinatorial description of the affine Gindikin-Karpelevich formula of type* $A_n^{(1)}$.

The classical Gindikin-Karpelevich formula appears in Langlands' calculation of the constant terms of Eisenstein series on reductive groups and in Macdonald's work on p-adic groups and affine Hecke algebras. The formula has been generalized in the work of Garland to the affine Kac-Moody case, and the affine case has been geometrically constructed in a recent paper of Braverman, Finkelberg, and Kazhdan. On the other hand, there have been efforts to write the formula as a sum over Kashiwara's crystal basis or Lusztig's canonical basis, initiated by Brubaker, Bump, and Friedberg. In this paper, we write the affine Gindikin-Karpelevich formula as a sum over the crystal of generalized Young walls when the underlying Kac-Moody algebra is of affine type $A_n^{(1)}$. The coefficients of the terms in the sum are determined explicitly by the combinatorial data from Young walls. (Received June 26, 2012)

1082-17-118 **Jonathan R Kujawa***, Dept. of Mathematics, University of Oklahoma, Norman, OK 73019-3103. *The Generalized Kac-Wakimoto Conjecture.*

Using a new point of view coming from low-dimensional topology, a few years ago Geer, Patureau-Mirand, and I introduced a generalization of the Kac-Wakimoto conjecture for Lie superalgebras. We discuss the proof of this conjecture for the classical Lie superalgebras and some consequences. (Received July 02, 2012)

1082-17-144 **Antun Milas***, 1400 Washington Ave, Albany, NY 12222. *Integral lattices and W-algebras.*

I will introduce certain remarkable W-algebras coming from infinite order automorphisms of lattice vertex algebras. I will report on a recent progress obtained for the algebras of "rank one", whose representation theory has been worked out in many details. In the second part, I will discuss the modular properties of characters of their representations and the related combinatorics, including various q-series identities. This talk is mainly based on joint work with D. Adamovic and M. Penn. (Received July 04, 2012)

1082-17-291 **Ben Elias***, belias@math.mit.edu. *A Quantum Satake equivalence for* $\mathfrak{sl}_2$.

We provide a 2-functor from the 2-colored Temperley-Lieb category at $q = 1$ to a suitable 2-category of singular Soergel bimodules. We describe how this is an algebraic version of the geometric Satake equivalence for $\mathfrak{sl}_2$. This construction has a natural q-deformation. When q is then specialized to a root of unity, one obtains an equivalence between representations of $U_q(\mathfrak{sl}_2)$ at that root of unity and singular Soergel bimodules for a finite dihedral group. The construction generalizes to $\mathfrak{sl}_n$, where roots of unity remain mysterious. (Received July 10, 2012)

18 ► Category theory; homological algebra

1082-18-169 **Jiuzu Hong*** (hjzzjh@gmail.com), Department of Mathematics, Yale University, 10 Hillhouse Avenue-#421DL, P.O. Box 208283, New Haven, CT 06520-8283. *The notion of categorical Heisenberg representation at positive characteristic and root of unity.* Preliminary report.

By work of Khovanov, Licata & Savage there is a notion of a strong categorical Heisenberg action on an abelian category. Their theory applies to categories defined over the field of characteristic zero and with generic parameter. We show how to extend their theory to positive characteristic and roots of unity by introducing constructions using (co)-equalizers instead of idempotents. In particular, we deduce categorical Heisenberg relations from a given Heisenberg action in general case. This is a joint work with Oded Yacobi. (Received July 06, 2012)

1082-18-277 **Amber Russell*** (amcarus@gmail.com) and **Laura Rider**. *Cuspidal Local Systems and a Decomposition of Perverse Sheaves on the Nilpotent Cone.* Preliminary report.

In a recent paper, Achar uses hyperbolic localization to give an orthogonal decomposition of the category of perverse sheaves on the nilpotent cone. In particular, he decomposes this category into those arrising from the Springer sheaf and those not. In this talk, I will discuss the ongoing project to generalize this result and decompose the category further with the use of Lusztig's cuspidal local systems. (Received July 09, 2012)

20 ► Group theory and generalizations

1082-20-130 **Craig J Dodge*** (cdodge2@allegheny.edu). *New results on decomposable Specht modules.* Joint work with Dr. Matthew Fayers.

We present a new family of decomposable Specht modules for the symmetric group in characteristic 2. These Specht modules are labelled by partitions of the form $(a, 3, 1^b)$, and are the first new examples found for thirty years. Our method of proof is to exhibit summands isomorphic to irreducible Specht modules, by constructing explicit homomorphisms between Specht modules. (Received July 03, 2012)

1082-20-258 **Joel Kamnitzer**, **Ben Webster**, **Alex Weeks** and **Oded Yacobi*** (oyacobi@math.toronto.edu). *Yangians and quantizations of slices in the affine grassmannian.*

We study slices to Schubert varieties in the affine grassmannian. These are natural objects from the point of view of geometric Satake - they correspond to weight spaces of irreducible representations. We quantize these slices using subqoutients of certain quantum groups called Yangians. Based on joint work with Kamnitzer, Webster, and Weekes. (Received July 09, 2012)

22 ► Topological groups, Lie groups

1082-22-72 **Bradley Currey*** (curreybn@slu.edu), Department of Mathematics and Comp. Science, Saint Louis University, Saint Louis, MO 63103, **Didier Arnal**, Université de Bourgogne, **Béchir Dali**, King Saud University, and **Vignon Oussa**, Bridgewater State University. *Orbit spaces for linear actions of solvable groups.* Preliminary report.

Let V be a real vector space of finite dimension and suppose that G is a solvable Lie group acting linearly on V. Let $V = V_0 \supset V_1 \supset \cdots \supset V_n = (0)$ be a sequence of invariant subspaces of V with $\pi_j : V \to V/V_j$ the natural map, so that the natural action of G on each V/V_j is irreducible. For each $v \in V$, the stabilizer $G(\pi_j(v))$ of $\pi_j(v)$ acts naturally on V_j/V_{j+1} by *affine* transformations. We say that a G-invariant set Ω is *reducibly regular* if there is a flag such that for each $1 \leq j < n$, both $\pi_j(\Omega)$ and V_j/V_{j+1} contain only *regular* orbits.

We present a construction of a stratification $\{\Omega\}$ of V into G-invariant subsets for which the action of G is described explicitly. If the action in Ω is reducibly regular, we construct an explicit cross-section for the orbits in Ω and describe the quotient topology. We describe large classes of actions that are reducibly regular, or where regular implies reducibly regular, and present applications to the continuous wavelet transform. This is joint work with D. Arnal and V. Oussa. (Received June 21, 2012)

1082-22-276 **Benjamin J Wyser*** (ben.wyser@gmail.com), University of Illinois at Urbana-Champaign, Department of Mathematics, 1409 W. Green St., Urbana, IL 61801. *K-orbits on the flag variety and degeneracy loci for flagged vector bundles with symmetric or skew-symmetric bilinear form.*

Let G be a complex reductive group, with θ an involution of G and $K = G^\theta$ the corresponding symmetric subgroup. K acts on the flag variety for G with finitely many orbits, and the geometry of these orbits and their closures is important in the representation theory of a certain real form of the group G.

We describe how equivariant localization and divided difference operators can be used to compute explicit formulas for the torus-equivariant fundamental classes of such orbit closures. We carry this out explicitly for the symmetric pairs $(GL(n,\mathbb{C}), O(n,\mathbb{C}))$ and $(GL(2n,\mathbb{C}), Sp(2n,\mathbb{C}))$. We then indicate how the equivariant formulas in these cases can be interpreted as Chern class formulas for certain degeneracy loci involving a vector bundle over a variety equipped with a complete flag of subbundles and a symmetric or skew-symmetric bilinear form. (Received July 09, 2012)

30 ► Functions of a complex variable

1082-30-49 **Paul M. Gauthier*** (gauthier@dms.umontreal.ca). *Approximating Functions by the Riemann Zeta-Function and by Polynomials with Zero Constraints.*

On certain compact sets K; we shall approximate functions having no zeros on the interior of K by translates of the Riemann zeta-function. As J. Andersson has shown recently, this is related to a natural problem in polynomial approximation. (Received June 11, 2012)

1082-30-51 **Paul M. Gauthier*** (gauthier@dms.umontreal.ca). *Approximating the Riemann zeta-function by strongly recurrent functions.*

Bhaskar Bagchi has shown that the Riemann hypothesis holds if and only if the Riemann zeta-function $\zeta(z)$ is strongly recurrent in the strip $1/2 < \Re(z) < $. We show that $\zeta(z)$ can be approximated by strongly recurrent functions which share important properties with $\zeta(z)$. (Received June 11, 2012)

1082-30-147 **Zhijian Wu*** (zwu@as.ua.edu), Department of Mathematics, The University of Alabama, Tuscaloosa, AL 35487. *Analytic Morrey spaces and Volterra Operators.* Preliminary report.

Analytic Morrey space and its equivalent norms are discussed, especially the norm related to the generalized Carleson measures. As an application, we characterize the analytic symbol function φ such that the Volterra operator V_φ is bounded (or compact) from Hardy spaces to analytic Morrey spaces.

For an analytic function φ on the unit disk D, the Volterra operator(also referred as Cesáro operator) with symbol φ is defined as

$$V_\varphi(f)(z) = \int_0^z f(w)\varphi'(w)dw\,, \quad z \in D\,.$$

Here f is an analytic function on the unit disk D. (Received July 04, 2012)

32 ► Several complex variables and analytic spaces

1082-32-6 **Maher M.H. Marzuq*** (maher_marzuq@yahoo.com), German Jordanian University, Department of Water Engineering and Managemen, PO Box 35247, Amman, 11180, Jordan. *A generalization of a dual theorem of Hardy and Littlewood over bounded circular domain on CN(N>1).*

We extend theorems of W. Y. Chan 1977 [2] from Hp(D)Ap(D)spaces. (Received February 20, 2012)

33 ► Special functions

1082-33-32 **Tanya Nichole Riston*** (tnr5033@psu.edu) and **Daniel J. Galiffa** (djg34@psu.edu), Penn State Erie, The Behrend College, 4205 College Drive, Erie, PA 16563. *A Full Characterization of the Sheffer A-Type 0 Orthogonal Polynomial Sequences.* Preliminary report.

In 1939, I.M. Sheffer published "Some Properties of Polynomial Sets of Type Zero," Duke Math J. 5, 590-622, which has been regarded as an indispensable paper in the theory of orthogonal polynomials. Therein, Sheffer basically proved that every polynomial sequence can be classified as belonging to exactly one *Type*. In addition

to various interesting and important characterizing theorems, one of Sheffer's most prominent results pertained to completely characterizing all of the polynomial sequences that were of the most basic type, entitled *A-Type 0*, and subsequently establishing which of these sets were also orthogonal. This yielded the very well-studied and applicable Laguerre, Hermite, Charlier, Meixner, Meixner-Pollaczek and Krawtchouk orthogonal polynomial sequences. However, Sheffer's elegant analysis relied heavily on various functional relationships and formal power series. In this talk, we demonstrate how all of the Sheffer *A-Type 0*, orthogonal polynomial sequences can be characterized by using only the generating function that defines this class and a monic three-term recurrence relation. (Received May 16, 2012)

1082-33-44 **Daniel J. Galiffa*** (djg34@psu.edu), Penn State Erie, The Behrend College, 4205 College Drive, Erie, PA 16563, and **Boon W. Ong** (bwo1@psu.edu), Penn State Erie, The Behrend College, 4205 College Drive, Erie, PA 16563. *Characterizing q-Orthogonal Polynomials via Difference Equations.* Preliminary report.

In this talk, we ultimately show how to obtain all of the q-orthogonal polynomial solutions to the difference equation $\mathcal{D}_q(P_n(x)) = \gamma_n P_{n-1}(x)$, where $\mathcal{D}_q$ is the Askey-Wilson degree-lowering, divided-difference operator defined by

$$\mathcal{D}_q f(x) = \frac{\breve{f}\left(q^{\frac{1}{2}}z\right) - \breve{f}\left(q^{-\frac{1}{2}}z\right)}{\breve{e}\left(q^{\frac{1}{2}}z\right) - \breve{e}\left(q^{-\frac{1}{2}}z\right)},$$

with $z = e^{i\theta}$, $\breve{f}(z) = f(x) = f(\cos\theta)$, for any function f and $e(x) = x$. We begin by discussing the how this equation was developed and its importance in characterizing q-orthogonal polynomials. Next, we show how we obtained its solution(s) via an interesting Chebyshev polynomial expansion technique. From there, we discuss future directions of this work and how other similar difference equations can be developed. (Received June 07, 2012)

34 ► Ordinary differential equations

1082-34-19 **Ludwig Kohaupt***, Department of Mathematics, Luxemburger Str. 10, 13353 Berlin, Germany. *Investigation of vibration problems $\dot{\boldsymbol{x}} = \boldsymbol{Ax}$, $\boldsymbol{x(t_0) = x_0}$ in weighted norms.*

By using a weighted norm, it is shown that one can get better two-sided bounds on the solution $x(t)$ of $\dot{x} = Ax$, $x(t_0) = x_0$ than before. The best constants in the bounds are obtained by the differential calculus of norms developed by the author in earlier work. (Received April 16, 2012)

1082-34-37 **Richard H Rand*** (rrand@cornell.edu). *Differential Equations with Fractional Derivatives : A Perturbation Approach.*

We use perturbation methods to study the nonlinear dynamics of DE's of the form:

$$x'' + x = \epsilon \mathcal{F}(x, x', D^{\alpha}x, t),\ \epsilon << 1$$

where $D^a x$ is the derivative of order α of $x(t)$, where $0 < \alpha < 1$ is a parameter. This presentation will review the basics of fractional calculus, and will illustrate the perturbation approach by giving some examples. (Received May 27, 2012)

1082-34-71 **Mihaela Cristina Drignei*** (mdrignei@pitt.edu), Division of Physical & Computational Sciences, University of Pittsburgh at Bradford, Bradford, PA 16701. *Numerical reconstruction for the potential of an inverse Sturm-Liouville problem with mixed boundary conditions.* Preliminary report.

This talk presents an algorithm for the reconstruction of the coefficient (also called 'potential') function in the canonical Sturm-Liouville differential operator. We use three known sequences of eigenvalues of this operator corresponding respectively to three sets of boundary conditions: Dirichlet for the entire interval, Dirichlet-Robin for a left subinterval, and Robin-Dirichlet for its complement. Numerical examples will also be presented, involving both continuous and discontinuous potential functions. (Received June 20, 2012)

35 ► Partial differential equations

1082-35-11 **Peter A. Perry*** (perry@ms.uky.edu), Department of Mathematics, University of Kentucky, Lexington, KY 40506-0027. *Solution of Two-Dimensional Dispersive Nonlinear Equations by the $\overline{\partial}$-method of Inverse Scattering.*

The Davey-Stewartson II (DS II) , modified Novikov-Veselov (mNV), and Novikov-Veselov (NV) equations are completely integrable, nonlinear evolution equations in two space dimensions which generalize the cubic nonlinear Schrodinger, modified Korteweg-de Vries equation, and Korteweg-de Vries equations in one dimension. We discuss recent work on global well-posedness for the DS II and mNV equations by $\overline{\partial}$-methods, and their application to the study of the NV equation. We will also discuss progress toward a "nonlinear stationary phase method" for $\overline{\partial}$ problems with oscillatory dependence on parameters such as those which define the direct and inverse scattering maps for the DS II and mNV equations. (Received February 01, 2012)

1082-35-46 **Alex A. Himonas***, Alex Himonas, University of Notre Dame, Department of Mathematics, Notre Dame, IN 46556-5683. *Ovsiannikov's theorem and weakly dispersive equations.* Preliminary report.

We shall discuss a refined version of Ovsiannikov's theorem for autonomous equations with initial data in a space of functions that extend analytically in a strip of the complex plane around the x-axis. Then, we will apply this result to some important weakly dispersive equations, namely Camassa-Holm type equations. (Received June 10, 2012)

1082-35-55 **Xiang Zhang*** (zhang@math.rochester.edu), Department of Mathematics, University of Rochester, 818 Hylan Building, Rochester, NY 14627. *A small data global well-posedness result for the $2+1$ dimensional equivariant Faddeev model.*

The static properties of the Faddeev theory, which arises in particle physics as a generalization of the classical nonlinear σ model, have been the subject of many investigations. However, its time evolution has not been studied until recently. A 2011 result of Lin-Lei-Zhou establishes global regularity in $2+1$ dimensions for smooth data which have small H^{11} norm. Here, we consider the corresponding equivariant problem, for which we prove a small data global well-posedness result at H^2 level. (Received June 12, 2012)

1082-35-87 **R Felea** (rxfsma@rit.edu), School of Mathematical Sciences, 85 Lomb Memorial Drive, Rochester, NY 14623-5603, **R Gaburro** (romina.gaburro@ul.ie), Dept. of Maths and Statistics, Plassey Park Road, Castletroy, Limerick , Ireland, and **C J Nolan*** (clifford.nolan@ul.ie), Dept. of Maths and Statistics, Plassey Park Road, Castletroy, Limerick , Ireland. *Microlocal analysis of radar imaging of a dynamic reflectivity function.* Preliminary report.

We extend the model for scattering of radio waves from a static object to one which is moving. Our approach is related to the recent papers of Cheney and Borden but we consider a more general reflectivity function and a variety of acquisition geometries. We express the scattered waves as the output of Fourier integral operator F that acts on a dynamic reflectivity function. The normal operator F^*F which arises in imaging of the latter function is analyzed and its distribution kernel is found to belong to the class of paired Lagrangian distributions. We are able to apply the results of Marhuenda to show that artifacts arise and are associated to a flow-out from the diagonal in the phase space of space-time. Furthermore, we show how such artifacts can be ameliorated by preprocessing the scattered waves with pseudo-differential operator. (Received June 27, 2012)

1082-35-90 **Tadahiro (Choonghong) Oh*** (hirooh@math.princeton.edu). *On the Cauchy problem of the one-dimensional cubic NLS in the low regularity setting.*

In this talk, we discuss some recent developments on the Cauchy problem for the one-dimensional cubic NLS both on $\mathbb{R}$ and $\mathbb{T}$. In view of ill-posedness results below L^2 in the periodic setting, we introduce the renormalized cubic NLS (Wick ordered cubic NLS) for which we prove an existence result (without uniqueness.) As a consequence, we show non-existence of weak solutions to the (usual) cubic NLS below $L^2(\mathbb{T})$. (Received June 27, 2012)

1082-35-95 **Oana Pocovnicu***, Fine Hall, Washington Rd, Princeton, NJ 08544-1000. *Effective dynamics of a non-linear wave equation.*

We consider the non-linear wave equation on the real line $iu_t - |D|u = |u|^2u$. Its resonant dynamics is given by the Szego equation, which is a completely integrable non-dispersive non-linear equation. We show that the solution of the wave equation can be approximated by that of the resonant dynamics for a long time. The proof uses the renormalization group method introduced by Chen, Goldenfeld, and Oono in the context of theoretical

physics. As a consequence, we obtain growth of high Sobolev norms of certain solutions of the non-linear wave equation, since this phenomenon was already exhibited for the Szego equation. (Received June 28, 2012)

1082-35-99 **Dmitry Pelinovsky*** (dmpeli@math.mcmaster.ca), Department of Mathematics, McMaster University, Hamilton, Ontario L8S 4K1, Canada. *Justification of the short-pulse equation.*

We prove that the short-pulse equation, which is derived from Maxwell equations with formal asymptotic methods, can be rigorously justified. The justification procedure applies to small-norm solutions of the short-pulse equation. Although the small-norm solutions exist for infinite times and include modulated pulses and their elastic interactions, the error bound for arbitrary initial data can only be controlled over finite time intervals. (Received June 29, 2012)

1082-35-126 **John A Toth*** (jtoth@math.mcgill.ca). *Quantum Ergodic Restriction for Laplace Eigenfunctions.*

Let (M, g) be a compact, closed Riemannian manifold with ergodic geodesic flow $G^t : S^*M \to S^*M$ and let $H \subset M$ be a smooth hypersurface. We show that under a very general microlocal asymmetry condition, the restrictions of the Laplace eigenfunctions to H are quantum ergodic. This is joint work with Steve Zelditch. (Received July 03, 2012)

1082-35-136 **E Bruce Pitman*** (pitman@buffalo.edu), Department of Mathematics, Buffalo, NY 14260. *Estimation and propagation of volcanic source parameter uncertainty and the Eyjafjallajökull plume.*

The 2010 eruption of the Eyjafjallajokull volcano wrecked havoc for European aviation. To make predictions of the likely position of the ash cloud and issue advisories to the airline industry, the London Volcanic Ash Advisory Center used mathematical models of advection and dispersion. These models require input data on source conditions such as eruption column height and mass loading, which are usually not well constrained. The outputs of these models also depend on other input data such as varying winds, which have stochastic variability. Estimates of all these uncertain inputs is needed to make probabilistic predictions of cloud motion. There has not been a systematic study of these variable and uncertain source inputs, and the consequent probabilistic output forecasts. We extend a recently developed computational method designed to minimize moment errors, to produce probabilistic ash cloud maps at different times. For validation, the PUFF cloud trajectory model is combined with the BENT eruption column model, to hindcast the motion of the Eyjafjallajokull ash cloud. (Received July 03, 2012)

1082-35-190 **Georgi Medvedev*** (medvedev@drexel.edu). *The geometry of spontaneous spiking in neuronal networks.*

As for partial differential equations, spatial extension is important for the time evolution of dynamical networks, such as systems of coupled differential equations defined on graphs. We discuss several applications of dynamical networks to neuroscience, emphasizing the use of combinatorial techniques for understanding network dynamics. (Received July 07, 2012)

1082-35-192 **Joseph Paullet*** (jep7@psu.edu) and **Susmita Sadhu**, Dept of Mathematics and Computer Science, Southwest Minnesota State University, Marshall, MN 56258. *Existence, Multiplicity and Asymptotic Behavior of Solutions to a Boundary Value Problem from Fluid Mechanics.*

In some instances, a similarity transformation can be used to reduce the PDEs governing fluid flow to boundary value problems involving ODEs. We will discuss two physical situations which can both be reduced to the following BVP:

$$f'''(\eta) + \left(\frac{k+2}{3}\right) f(\eta) f''(\eta) - \left(\frac{2k+1}{3}\right) f'(\eta)^2 = 0, \quad 0 < \eta < \infty$$

subject to

$$f(0) = 0, \quad f''(0) = -1, \quad f'(\infty) = 0$$

where $k > -1$ is a physical parameter and $f(\eta)$ is related to the stream function. Previous numerical investigations of this BVP report the existence of a unique solution for all $k > -1$. In this talk we will prove that while a solution does exist for all $k > -1$, it is not unique in the range $-1 < k < -1/2$. We conjecture that the solution is unique for $k \geq -1/2$ but can only prove it for $-1/2 \leq k \leq 1$. For $k \in (-1, -1/2)$ an infinite continuum of solutions exists. By considering the asymptotic behavior of these solutions as $\eta \to \infty$ we will show that precisely one solution has $f'(\eta)$ decaying to zero exponentially while all others have $f'(\eta)$ decaying algebraically.

Implications regarding the stability of the similarity solution in the full PDEs will also be discussed. (Received July 10, 2012)

1082-35-193 **J. Douglas Wright*** (jdoug@math.drexel.edu). *Well-posedness Issues in Degenerate Dispersive Equations.*

Linear dispersion plays a fundamental role in the study of a large number of physical scenarios and has been the subject of intense theoretical development in recent years. Consequently there has been an explosion of results concerning nonlinear dispersive equations. Nevertheless there are situations in which the mechanism which creates dispersion is itself nonlinear and degenerate. Examples can be found in the study of sedimentation, magma dynamics, granular media, numerical analysis and elasticity. Little is understood about general well-posedness issues for such equations. In this talk we will discuss some recent results which show that degenerate dispersive effects can result in catastrophic instability akin to a backwards heat equation. (Received July 07, 2012)

1082-35-195 **Vedran Sohinger*** (vedranso@math.upenn.edu), David Rittenhouse Laboratory, 209 South 33rd Street, Philadelphia, PA 19104, and **Robert Strain** (strain@math.upenn.edu), David Rittenhouse Laboratory, 209 South 33rd Street, Phialdelphia, PA 19104. *The Boltzmann equation, Besov spaces, and optimal time decay rates in $\mathbb{R}^n$.*

We study the large-time convergence to the global Maxwellian of perturbative classical solutions to the Boltzmann equation on $\mathbb{R}^n$, for $n \geq 3$, without the angular cut-off assumption. We prove convergence of the k-th order derivatives in the norm $L^x_r(L^2_v)$, for $2 \leq r \leq \infty$, with optimal decay rates, in the sense that they are equal to the rates which one obtains for the corresponding linear equation. The initial data is assumed to lie in a mixed norm space involving the negative homogeneous Besov space of order $\geq -\frac{n}{2}$ in the velocity variable, without a smallness assumption on the appropriate norm. The space for the initial data is physically relevant since it contains $L^2_v(L^p_x)$, by Sobolev embedding. Due to the nature of the vector valued spaces, we need to use a vector analogue of the Calderon-Zygmund theory to prove the necessary nonlinear energy estimates. These results hold both in the hard and soft potential case. In the hard potential case, we prove additional optimal decay results if the order of the Besov space belongs to $[-\frac{n+2}{2}, -\frac{n}{2})$ by using a closer study of the spectrum of the linearized Boltzmann operator for small frequencies dual to the spatial variable. This is a joint work with Robert Strain. (Received July 07, 2012)

1082-35-196 **J. Colliander**, **M. Czubak*** (czubak@math.binghamton.edu) and **C. Sulem**. *Lower bound for the rate of blowup of singular solutions of the Zakharov system in 3D.* Preliminary report.

The Zakharov system describes the phenomenon of propagation of Langmuir waves in a non-magnetized plasma. We discuss the question of the rate of blow-up of solutions for the Zakharov system in three dimensions, and we establish a lower bound for the rate of blow-up of appropriate Sobolev norms. (Received July 07, 2012)

1082-35-202 **Dean Baskin** and **Andras Vasy***, Department of Mathematics, Bldg 380, 450 Serra Mall, Stanford, CA 94305-2125, and **Jared Wunsch**. *Asymptotics of radiation fields in asymptotically Minkowski spaces.* Preliminary report.

I will describe recent work with Dean Baskin and Jared Wunsch on the asymptotics of solutions of the wave equation on asymptotically Minkowski spaces. These generalize Minkowski space in the same sense that 'scattering metrics' introduced by Melrose generalize Euclidean space, though more stringent assumptions are required in some respects due to the non-elliptic nature of the operator. (Received July 08, 2012)

1082-35-210 **Dimitris Kontogiannis*** (dkontog@alumni.iastate.edu). *Connectivity and random graphs in the modeling of random physical systems.*

In this talk, we focus on the application of connectivity functions in the asymptotic behavior of partial differential equations and energy functionals. A connectivity function is a function $g : \mathbb{R} \to [0, 1]$ which connects two points $x, y \in \mathbb{Z}^d$ with a line segment with endpoints x, y. We connect the points with probability $g(|x-y|)$ independently of other points. We use the connectivity function to study two different averaging problems:

(1) The asymptotic behavior of elliptic equations with Dirichlet and Neumann boundary conditions in randomly perforated domains.

(2) The convergence in energy of a system of interacting particles in the form

$$E_\varepsilon(u) = \sum_{x,y \in \varepsilon\mathbb{Z}^d, x \neq y} \Phi_\varepsilon(u(x) - u(y), x - y)$$

(Received July 08, 2012)

1082-35-217 **Zuoqin Wang*** (wangzuoq@umich.edu). *Spectral invariants for the perturbed harmonic oscillator.*

In this talk we will study a semiclassical heat trace expansion for perturbations of the harmonic oscillator. Using the expansion we can obtain certain inverse spectral results. This is a joint work with Victor Guillemin and Alejandro Uribe. (Received July 09, 2012)

1082-35-218 **James E. Colliander*** (colliand@math.toronto.edu). *Recent progress on nonlinear Hamiltonian PDE.*

This talk will report on recent work on nonlinear dispersive equations. (Received July 09, 2012)

1082-35-219 **Dong Li*** (dli@math.ubc.ca), Room 121, 1984 Mathematics Road, Vancouver, BC V6T 1Z2. *Recent results on the Skyrme model.*

I will explain some recent progress on the Skyrme model. (Received July 09, 2012)

1082-35-224 **Longzhi Lin***, Department of Mathematics, Rutgers University, 110 Frelinghuysen Road, Piscataway, NJ 08854-8019. *Uniform convergence of harmonic map heat flow at infinite time.*

In this talk we will present an energy convexity along the harmonic map heat flow with small initial energy and fixed boundary data on the unit 2-disk. In particular, this implies that such harmonic map heat flow converges uniformly in time strongly in the $W^{1,2}$-topology, as time goes to infinity, to the unique limiting harmonic map. (Received July 09, 2012)

1082-35-226 **Dan Andrei Geba** and **David Karapetyan***, University of Rochester, Department of Mathematics, Rochester, NY 14627. *On the well-posedness of a modified Boussinesq equation.* Preliminary report.

In this talk, we discuss new results addressing the well-posedness and ill-posedness for a 1-dimensional modified Boussinesq equation. The proof is based on the construction of appropriate Bourgain-type spaces and a general framework due to Bejenaru and Tao. (Received July 09, 2012)

1082-35-227 **Romina Gaburro*** (romina.gaburro@ul.ie), Department of Mathematics and Statistics, University of Limerick, Limerick, Ireland. *Enhanced imaging from multiply scattered waves.*

Many imaging methods involve probing a material with a wave and observing the back-scattered wave. The back-scattered wave measurements are used to compute an image of the internal structure of the material. Many of the conventional methods make the assumption that the wave has scattered just once from the region to be imaged before returning to the sensor to be recorded. The purpose of this talk is to show how this restriction can be partially removed and also how its removal leads to an enhanced image, free of the artifacts often associated with the conventionally reconstructed image. The theory of microlocal analysis is here used in order to explain how the imaging works, how artifacts arise, and how they may be eliminated. (Received July 09, 2012)

1082-35-233 **Joachim Krieger**, **Jacob Sterbenz** and **Daniel Tataru*** (tataru@math.berkeley.edu), Department of Mathematics, University of California, Berkeley, Berkeley, CA 94720. *The Energy critical Maxwell-Klein Gordon equation.*

The aim of this talk is to present some new results concerning global finite energy solutions for the Maxwell-Klein Gordon system in 4+1 dimensions. (Received July 09, 2012)

1082-35-260 **Xuan Hien Nguyen*** (xhnguyen@iastate.edu), Department of Mathematics, 396 Carver Hall, Ames, IA 50011. *Self-translating surfaces under mean curvature flow.*

Self-translating surfaces play an important role in the study of the mean curvature flow because they can model the behavior of the flow near singularities under certain conditions. We present new examples constructed using gluing techniques and discuss properties of self-translating surfaces in general. (Received July 09, 2012)

1082-35-269 **David S. Ross*** (dsrsma@rit.edu), 85 Lomb Memorial Drive, Rochester, NY 14623, and **George M. Thurston** and **Christopher Wahle**. *The Fully Nonlinear Light Scattering PDE: Analysis and Application to Statistical Mechanics.*

In recent work we have shown that Gibbs free energies of multicomponent mixtures can be inferred from light scattering data–specifically, from measured Rayleigh ratios–by solving a characteristic boundary value problem for a fully nonlinear degenerate elliptic PDE. The computed Gibbs free energies provide rich characterizations of the thermodynamics of such mixtures, they provide full phase diagrams, including stability regions, coexistence manifolds, tie lines, and multi-phase coexistence polytopes.

In this talk we will summarize the formulation of the PDE problem and its relation to the thermodynamics of mixtures. We will touch on existence and uniqueness and we will show how perturbation analysis yields a Fichera problem that can be used to characterize the sometimes-complex pattern of domains of dependence in the phase plane. We will discuss experimental design considerations associated with this method of measuring free energies, and numerical issues associated with high-dimensional cases, (an N-component mixture yields an N+1 dimensional PDE). Finally, we will discuss alternate boundary value problems and their roots in thermodynamics and experimental constraints. (Received July 09, 2012)

1082-35-271 **ShiTing Bao** (ellenbao@pitt.edu), Department of Mathematics, University of Pittsburgh, Pittsburgh, PA 15260, **Ming Chen*** (mingchen@pitt.edu), Department of Mathematics, University of PIttsburgh, Pittsburgh, PA 15260, and **Qing Liu** (qingliu@pitt.edu), Department of Mathematics, University of Pittsburgh, Pittsburgh, PA 15260. *Existence and symmetry of ground states to the Boussinesq systems.*

We consider a four-parameter family of Boussinesq systems derived by Bona-Chen-Saut. We establish the existence of the ground states which are solitary waves minimizing the action functional of the systems. We further show that in the presence of large surface tension the ground states are even up to translation. This is a joint work with Ellen ShiTing Bao and Qing Liu. (Received July 09, 2012)

1082-35-285 **Gino Biondini*** (biondini@buffalo.edu), SUNY at Buffalo, Department of Mathematics, Math Dept, Putnam Way, Buffalo, NY 14260. *Solitons, boundary value problems and a nonlinear method of images.*

Boundary value problems (BVPs) for integrable nonlinear evolution equations cannot be fully linearized in general, except for special kinds of boundary conditions (BCs), called linearizable. I will discuss discrete and continuous nonlinear Schrodinger (NLS) equation on the half line, both in the focusing and the defocusing case (the latter with non-zero BCs at infinity). All these BVPscan be treated by extending the potential to the whole line and using the inverse scattering transform of the initial value problem. Homogeneous Dirichlet and Neumann BCs can be dealt with using even and odd extensions. Robin BCs can be treated using a special type of auto-Backlund transformations. In all these cases, the extended problem is characterized by extra symmetries, which impose corresponding symmetries in the scattering coefficients. As a result, discrete eigenvalues appear in symmetric pairs (for defocusing NLS), symmetric quartets (focusing NLS) or symmetric octets (AL). In turn, these properties imply that, for every physical soliton, a "mirror" soliton exists, located beyond the boundary, which mediates the reflection experienced by the physical soliton at the boundary. These results provide a nonlinear analogue of the method of images. (Received July 10, 2012)

1082-35-290 **Marius Beceanu*** (mbeceanu@uchicago.edu). *A Centre-Stable Manifold for the Energy-Critical Wave Equation in $\mathbb{R}^3$ in the Symmetric Setting.*

Consider the focusing semilinear wave equation in $\mathbb{R}^3$ with energy-critical nonlinearity

$$\partial_t^2\psi - \Delta\psi - \psi^5 = 0,\ \psi(0) = \psi_0,\ \partial_t\psi(0) = \psi_1.$$

This equation admits stationary solutions of the form

$$\phi(x,a) := (3a)^{1/4}(1 + a|x|^2)^{-1/2},$$

called solitons, which solve the elliptic equation

$$-\Delta\phi - \phi^5 = 0.$$

Restricting ourselves to the space of symmetric solutions ψ for which $\psi(x) = \psi(-x)$, we find a local centre-stable manifold, in a neighborhood of $\phi(x,1)$, for this wave equation in the weighted Sobolev space $\langle x\rangle^{-1}\dot{H}^1 \times \langle x\rangle^{-1}L^2$. Solutions with initial data on the manifold exist globally in time for $t \geq 0$, depend continuously on initial data, preserve energy, and can be written as the sum of a rescaled soliton and a dispersive radiation term.

The proof is based on a new class of reverse Strichartz estimates, introduced in [BeGo] and adapted here to the case of Hamiltonians with a resonance. (Received July 10, 2012)

1082-35-307 **Clarissa C. Garvey*** (ccg9648@rit.edu) and **Nathan D. Cahill**. *Nonrigid Registration of 3D Medical Images using Fractional Partial Differential Equations.*

Image registration is used in medical imaging to compare images of the same structure that are captured at different times, with different modalities, or both. In clinical situations where the structure is deformed, nonrigid image registration can be performed by solving an inhomogeneous diffusion equation. Recent research proposed the use of a fractional diffusion equation (FDE) for solving the nonrigid registration problem. However, the research used simplistic assumptions in its methods for numerically solving the FDE. This research uses standard discretizations of the fractional Laplacian operator combined with Fourier transformation based approaches to

efficiently solve the FDE. The resulting process was implemented in MATLAB and incorporated into an existing nonrigid image registration program. The algorithm was validated using 3D magnetic resonance breast images. (Received July 10, 2012)

1082-35-314 **Manoussos G Grillakis*** (mggrlk@math.umd.edu), Department of Mathematics, University of Maryland, College Park, MD 20742. *Pair excitations and the mean field evolution of interacting Bosons.*

I would like to consider the evolution of N indistinguishable Quantum particles (Bosons), for N large but finite. The basic problem is that of an effective (approximate) description of the evolution. The mean field approximation achieves this goal (for special initial data) by describing all particles by the same wave-function $\phi(t,x)$ which satisfies a Hartree type evolution. I will explain how to introduce a second order correction which describes pair excitations and derive a pair of linear equations describing their evolution. Finally I will compare the exact with the approximate dynamics which stay close for time of order e^{N^ϵ}. Part of this work is in collaboration with Matei Machedon and Dio Margetis and part with Matei Machedon. (Received July 10, 2012)

1082-35-320 **Martina Chirilus-Bruckner*** (martina_chirilus-bruckner@brown.edu), 182 George Street, Providence, RI 02912, and **Clarence Eugene Wayne** (cew@math.bu.edu), 111 Cummington Street, Boston, MA 02215. *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 July 10, 2012)

1082-35-329 **Taufiquar R Khan*** (khan@clemson.edu), O-201 Martin Hall, Box 340975, Clemson, SC 29672. *A Trilinear Form and L_p Parameter Differentiability in Diffuse Optical Tomography.*

In this talk, a sparsity constrained reconstruction problem in Diffuse Optical Tomography (DOT) will be presented to motivate the need for L_p differentiability with respect to the optical parameters. Then we will formulate a trilinear form and prove L_p differentiaibility of the forward operator in DOT. (Received July 11, 2012)

37 ► Dynamical systems and ergodic theory

1082-37-158 **Niels F Otani*** (nfo1@cornell.edu), Department of Biomedical Science, Veterinary Research Tower, Cornell University, Ithaca, NY 14853. *Cardiac defibrillation in two spatial dimensions using patterns of unequally spaced electric field stimuli.* Preliminary report.

Atrial and ventricular fibrillation, important rhythm disorders of the heart, are thought to be caused by the presence of several rotating "action potential" waves. Recently, we demonstrated that we could terminate a single such wave, rotating in ring geometry in a coupled-maps simulation model, by applying patterns of three, unequally spaced, pulsed electric field stimuli. Importantly, the wave is stopped regardless of its instantaneous dynamical state at the time the stimuli are applied. This suggests that it might be possible to terminate fibrillation by simultaneously stopping all its constituent rotating waves using stimulus protocols of this type. In our present study, we demonstrate that the same termination mechanism operative in the ring also works in two spatial dimensions when applied to rotating spiral waves. A variant involving wavefront curvature is also found effective. A complication that appears in two dimensions is the need to stop the entire wavefront, not just portions of it, which apparently eliminates the ability of patterns of three stimuli to terminate spiral waves independently of dynamical state. The landscape of the interstimulus-interval parameter space looks promising, however, when applied to the use of four or more unequally spaced stimuli. (Received July 05, 2012)

1082-37-182 **Laura M. Munoz*** (lm288@cornell.edu), Box 17 Veterinary Research Tower, Department of Biomedical Sciences, Cornell University, Ithaca, NY 14853, and **Niels F. Otani**, **Anna R. M. Gelzer**, **Flavio H. Fenton**, **Wei Lin**, **Min Chul Shin**, **Andrea Liu** and **Robert F. Gilmour, Jr**. *Mathematical modeling of the influence of premature beats in the formation of cardiac arrhythmias.* Preliminary report.

Sudden cardiac arrest is a leading cause of death in the industrialized world. Most cases of sudden cardiac arrest are due to ventricular fibrillation (VF), a lethal heart arrhythmia that may result when a normal rhythm is interrupted by a short sequence of premature beats. A nonlinear mathematical model of a cardiac fiber was developed to gain improved understanding of the role of premature beats in VF formation. In recent studies, this model was shown to be able to predict which sequences of premature beats were more likely to produce VF in canine hearts *in vivo*. The more recent phase of the study has been focused on determining the extent to which the predictions of the model agree with more detailed observations obtained from *in vitro* cardiac data sets. The results of this investigation may lead to improved models, in addition to new methods for anticipating and preventing VF. (Received July 06, 2012)

39 ► Difference and functional equations

1082-39-38 **Youssef Naim Raffoul*** (yraffoul1@udayton.edu), 300 College Park, Department of Mathematics, Dayton, OH 45469-2316. *Necessary and Sufficient Conditions For Uniform Boundedness In Functional Difference Equations.*

We prove general theorems in which we give necessary and sufficient conditions for uniform boundedness and uniform ultimate boundedness for functional difference systems of the form

$$x(n+1) = G(n, x_n),\ x(n) \in \mathbb{R}^k \tag{1}$$

where $G : \mathbb{Z}^+ \times \mathbb{R}^k \to \mathbb{R}^k$ is continuous in x. We apply our results to finite and infinite delay Volterra difference equations by displaying suitable Lyapunov functionals.

(Received May 27, 2012)

1082-39-39 **Sukanya Basu*** (basus@gvsu.edu), Department of Mathematics, A-2-178 Mackinac Hall, 1 Campus Drive, Allendale, MI 49401-6495. *Periodicity and Chaos in Some Planar Discrete Dynamical Systems with Negative Feedback.* Preliminary report.

Oscillatory dynamics occur in many real-life applications such as, for example, circadian rhythms in gene regulatory networks. One way to better understand such oscillatory dynamics is to study mathematical models involving discrete dynamical systems with negative feedback interconnections. In this talk, I will discuss the oscillatory behavior of solutions to a class of discrete dynamical systems in the plane with negative feedback. More specifically, I will give some general yet simple criteria to determine when solutions of such discrete dynamical systems show oscillatory stability in the form of periodicity and when they exhibit oscillatory instability in the form of chaos. (Received June 01, 2012)

1082-39-45 **Anatoli F Ivanov*** (afi1@psu.edu), Old Rt 115, P.O. Box PSU, Lehman, PA 18627. *Dynamics in difference equations arising from periodic differential delay equations.* Preliminary report.

We study dynamical properties of the following differential delay equation

$$x'(t) = a(t) f(x([t-K])), \tag{1}$$

where f is a continuous real-valued function satisfying the negative feedback condition $x \cdot f(x) < 0, x \neq 0$, $0 < a(t)$ is a continuous ω-periodic function, $[\cdot]$ is the integer part function, and the non-negative integer K in the delay. Equation (1) can be viewed as a discretization or a discrete version of the differential delay equation

$$x'(t) = a(t) f(x(t-\tau)), \quad \tau > 0. \tag{2}$$

While the dynamics of equation (2) are largely unstudied due to the complexity of the problem, some of the interesting dynamical properties of equation (1) can be derived based on its reduction to difference equations.

We consider two special cases in equation (1): (i) period ω is integer, and (ii) $K = 0$. In case (i) the dynamics of (1) are reducible to those of a finite-dimensional discrete map, while in case (ii) they are completely described by a one-dimensional map. We derive conditions for the existence of periodic solutions in equation (1) together with some further dynamical properties. (Received June 08, 2012)

1082-39-52 **Jessica A. Krawec*** (jkra8575@my.msmc.edu), Mount Saint Mary College, Division of Math, 330 Powell Ave., Newburgh, NY 12550, and **Zachary A. Kudlak**. *On the Non-Autonomous System* $x_{n+1} = \frac{\alpha_n}{B_n x_n + y_n}$, $y_{n+1} = \frac{\gamma_n}{C_n x_n + y_n}$ *with periodic coefficients.* Preliminary report.

We investigate the behavior of systems of rational difference equations with periodic coefficients. In particular, we explore the boundedness of these sequences. One such system, $x_{n+1} = \dfrac{\alpha_n}{B_n x_n + y_n}$, $y_{n+1} = \dfrac{\gamma_n}{C_n x_n + y_n}$, for $n \geq 0$, is unbounded in both equations for a given range of parameters. It is interesting to note that the autonomous analog of this system is bounded in both equations. (Received June 12, 2012)

1082-39-53 **Candace M. Kent*** (cmkent@vcu.edu), Department of Mathematics & Applied Math., 1015 Floyd Avenue, P.O. Box 842014, Richmond, VA 23284-2014, and **Michael A. Radin**. *On the Boundedness Nature of Positive Solutions of the Difference Equation* $x_{n+1} = \max\left\{\dfrac{A_n}{x_{n-k}}, \dfrac{B_n}{x_{n-l}}\right\}$ *with Periodic Parameters.* Preliminary report.

We investigate the boundedness nature of positive solutions of the difference equation

$$x_{n+1} = \max\left\{\frac{A_n}{x_{n-k}}, \frac{B_n}{x_{n-l}}\right\}, \ n = 0, 1, \ldots,$$

where $k, l \in \{0, 1, \ldots\}$ and $\{A_n\}_{n=0}^{\infty}$ and $\{B_n\}_{n=0}^{\infty}$ are periodic sequences of positive real numbers with prime periods p and q, respectively. We give sufficient conditions on p and q for the existence of unbounded solutions. (Received June 12, 2012)

1082-39-57 **Emmanouil Drymonis**, **Yevgeniy Kostrov** and **Zachary Kudlak*** (zachary.kudlak@msmc.edu), Mount Saint Mary College, Newburgh, NY 12550. *On a System of Rational Difference Equations with Periodic Coefficients.* Preliminary report.

In this preliminary report, we investigate the limiting behavior and boundedness character of several systems contained in:

$$x_{n+1} = \frac{\alpha_n}{B_n x_n + y_n}, \quad y_{n+1} = \frac{a_n + c_n x_n + d_n y_n}{A_n + C_n x_n + D_n y_n}, \quad n = 0, 1 \ldots$$

where $\{\alpha_n\}$, $\{B_n\}$, $\{a_n\}$, $\{c_n\}$, $\{d_n\}$, $\{A_n\}$, $\{C_n\}$, $\{D_n\}$ are nonnegative periodic sequences of real numbers. (Received June 13, 2012)

1082-39-69 **Chris D Lynd*** (chris_lynd@my.uri.edu). *A Period-2 Trichotomy for a Family of Systems of Rational Difference Equations.*

A period-2 trichotomy is a type of global bifurcation. In this talk, we present 20 different systems of rational difference equations that possess the same period-2 trichotomy. Our analysis utilizes a global convergence theorem from Camouzis and Ladas, and two theorems from Kulenovic and Merino that apply to competitive systems. (Received June 19, 2012)

1082-39-70 **Harold M. Hastings*** (harold.hastings@hofstra.edu), Dept of Physics - Berliner 102, 151 Hofstra University, Hempstead, NY 11549-1510. *Defibrillating the economy – lessons from stability of systems of difference equations.*

Systems of difference equations have been used to model many complex systems, including ecosystems, the cardiac electrical system and economic systems. As Gary Harrison observed, complex systems can be stable in one sense (Lyapunov, structural, resilient, resistant) but unstable in another (American Naturalist, 1979). We observed how this informs the stability-complexity debate by analyzing the structural stability of some ecosystem models (BioSystems, 1984). More generally, a small perturbation of a system in one of many stable equilibria dies out, but a sufficiently large perturbation can move the system from one equilibrium to another; similarly for more complex attractors. We shall explore this theme in the context of difference equations as a conceptual model for the ineffectiveness of small stimuli in both cardiac defibrillation and moving the economy. (Received June 20, 2012)

1082-39-101 **E A Grove**, **D Hadley** and **E G Lapierre*** (evelina@cox.net), 679 Cooper Road, Chepachet, RI 02814, and **S W Schultz**. *On the global behavior of two systems of rational difference equations.*

We investigate two systems of rational difference equations with parameters and initial conditions that are positive real values. For one system, we show that it is permanent and has a unique positive equilibrium which is locally asymptotically stable. We also find sufficient conditions to insure that the unique positive equilibrium is globally asymptotically stable. For the second system, we show that it is permanent and we find sufficient conditions to insure that every positive solution of the system converges. (Received June 29, 2012)

41 ► Approximations and expansions

1082-41-68 **Nathaniel S Barlow*** (barlow.nate@gmail.com), **Andrew J Schultz**, **Steven J Weintstein** and **David A Kofke**. *An asymptotically consistent approximant method with application to soft and hard-sphere fluids.*

A modified Padé approximant is used to construct an equation of state which has the same large density asymptotic ($\rho \to \infty$) behavior as the model fluid being described, while still retaining the low density behavior of the virial equation of state (VEOS). Within this framework, all sequences of rational functions that are analytic in the physical domain converge to the correct behavior at the same rate, eliminating the ambiguity of choosing the correct form of Padé approximant. The method is applied to fluids composed of "soft" spherical particles with separation distance r interacting through pair potentials, $\phi{=}\epsilon(\sigma/r)^n$, where ϵ and σ are model parameters and n is the "hardness" of the spheres. (Received June 18, 2012)

42 ► Fourier analysis

1082-42-27 **Vijayarangan Natarajan*** (n.vijayarangan@tcs.com), Tata Consultancy Services Ltd (TCS), TCS Innovation Labs, Chennai, 600086, India. *Biometric methods using correlation filters and FFTs.*

Biometric recognition is currently active research area with focus on to improve idenfication mechansisms. There are research topics in biometrics like Multiface camera recognition, Fusion of biometric information, Cancelable biometrics, Fourier phase in biometrics and Irisatadistance recognition without having proper products or tools available in the worldwide market. It is wise to bring out biometric products in the above areas using correlation filters approach on 2D, 3D FFTs and Parallel hypercube FFTs. It looks out to do more research focus on correlation filters that could exhibit better tolerance on noise and illumination variations than other spatial domain methods. While investing these biometric areas, the outcomes will provide benefits to many strategic divisions and banking services. (Received May 11, 2012)

1082-42-31 **Daryl Geller**, Stony Brook, NY 11794-365, and **Isaac Z Pesenson*** (pesenson@temple.edu). *Kolmogorov and Linear Widths of Balls in Sobolev spaces on Compact Manifolds.*

Daryl Geller and I were working on this paper during the Summer and Fall of 2010. Sadly, Daryl Geller passed away suddenly in January of 2011. I will always remember him as a good friend and a wonderful mathematician.

We determine upper asymptotic estimates of Kolmogorov and linear widths of unit balls in Sobolev norms on compact Riemannian manifolds. For compact homogeneous manifolds, we establish estimates which are asymptotically exact, for the natural ranges of indices. The proofs heavily rely on our previous results such as: estimates for the near-diagonal localization of the kernels of elliptic operators, Plancherel-Polya inequalities on manifolds, cubature formulas with positive coefficients and uniform estimates on Clebsch-Gordon coefficients on general compact homogeneous manifolds.

This work was supported in part by the National Geospatial-Intelligence Agency University Research Initiative (NURI), grant HM1582-08-1-0019. (Received May 15, 2012)

1082-42-40 **Alex Iosevich*** (iosevich@math.rochester.edu), 145 Dunrovin Lane, Rochester, NY 14618. *Distribution of lattice points in annuli and Falconer type problems in geometric measure theory.*

We are going to establish a link between the problem of distribution of lattice points in thin annuli, Sobolev bounds for generalized Radon transforms and Falconer type problems in geometric measure theory. This is joint work with Krystal Taylor. (Received June 05, 2012)

1082-42-41 **Alex Iosevich*** (iosevich@math.rochester.edu), 145 Dunrovin Lane, Rochester, NY 14618. *Bilinear estimates and applications.*

We shall prove and $L^2 \times L^2 \to L^2$ estimate for bilinear operators and apply it to problems in harmonic analysis, partial differential equations and geometric measure theory. (Received June 05, 2012)

1082-42-42 **Michael Christ*** (mchrist@math.berkeley.edu), Department of Mathematics, University of California, Berkeley, CA 94720. *Near-extremizers of affine-invariant inequalities, and arithmetic progressions.*

Inequalities which are invariant under the full group of all affine automorphisms of Euclidean space are rare, but include such fundamental examples as Young's convolution inequality, the Riesz-Sobolev rearrangement inequality, the Brunn-Minkowski inequality, and an inequality in Lebesgue spaces for the Radon transform. Optimal constants and extremizers for the first three of these have long been known. We discuss the characterization of near-extremizers, that is, those functions which nearly realize the optimal constants in these inequalities. The analysis is closely connected with a fundamental result in additive combinatorics due to Freiman, which characterizes finite subsets of the integers whose sumsets are very small. (Received June 06, 2012)

1082-42-47 **gopala krishna srinivasan*** (gopal@math.iitb.ac.in), Department of Mathematics, Indian Institute of Technology Bombay, Powai, Mumbai, 400076, India, and **Debraj Chakrabarti**. *On a remarkable formula of Ramanujan.*

The formula of Ramanujan for the Fourier transform of the square of the modulus of the gamma function along vertical lines in the right half plane belongs to a class of integrals considered by Mellin, Barnes and Hecke. We investigate the scope of the formula when the vertical line is not in the right half plane. We determine the jump in the Fourier transform across the imaginary axis using some results from ordinary differential equations. Besides we give a transparent new proof of Ramanujan's result in the spirit of Fourier Analysis. (Received June 11, 2012)

1082-42-63 **Seungly Oh*** (soh@math.ku.edu), Mathematics Department, 202 Mathematical Sciences Bldg, University of Missouri, Columbia, MO 65211. *Resonant phase-shift and global smoothing of the periodic Korteweg-de Vries equation in low regularity settings.*

We show a smoothing effect of near full derivative for low-regularity global-in-time solutions of the periodic Korteweg-de Vries (KdV) equation. The smoothing is given by slightly shifting the space-time Fourier support of the nonlinear solution, which we call *resonant phase-shift*. More precisely, we show that $[\mathcal{S}u](t) - e^{-t\partial_x^3}u(0) \in H^{-s+1-}$ where $u(0) \in H^{-s}$ for $0 \leq s < 1/2$ where $\mathcal{S}$ is the resonant phase-shift operator described below. We use the normal form method to obtain the result. (Received June 18, 2012)

1082-42-74 **Yen Do**, **Richard Oberlin** and **Eyvindur Ari Palsson*** (palsson@math.rochester.edu), UR Mathematics, 915 Hylan Building, RC Box 270138, Rochester, NY 14627. *Variational bounds for a dyadic model of the bilinear Hilbert transform.*

Variation norms, which are stronger than supremum-norms, are at least as old as Winer's paper on quadratic variation from the 1920s. D. Lépingle was the one though that pioneered variational estimates and proved them for martingales. Subsequently such estimates have been established for other families of operators in harmonic analysis such as families of averages and singular integrals. Examples of applications of these norms can be found both in ergodic theory and rough path analysis.

We will present variation-norm estimates for the Walsh model of the truncated bilinear Hilbert transform, extending related results of Lacey, Thiele and Demeter. The proof uses analysis on the Walsh phase plane and two new ingredients: (i) a variational extension of a lemma of Bourgain by Nazarov–Oberlin–Thiele, and (ii) a variation-norm Rademacher–Menshov theorem of Lewko–Lewko.

This is joint work with Y. Do and R. Oberlin. (Received June 23, 2012)

1082-42-78 **Akram Aldroubi***, akram.aldroubi@vanderbilt.edu, and **Ilya Krishtal** and **Jacqueline Davis**. *Dynamical Sampling: Time-Space Trade-off.*

We consider the problem of spatiotemporal sampling in which an initial state of an evolution process is to be recovered from a set of samples at different time levels. We are particularly interested in lossless trade-off between spatial and temporal samples. We show that for a special class of signals it is possible to recover the initial state using a reduced number of measuring devices activated more frequently. We present several algorithms for this kind of recovery and describe their robustness to noise. (Received June 25, 2012)

1082-42-129 **Dan Geba**, **Allan Greenleaf*** (allan@math.rochester.edu), **Alex Iosevich** and **Eyvindur Palsson**, Department of Mathematics, University of Rochester, Rochester, NY 14627, and **Eric Sawyer**, Department of Mathematics and Statistics, McMaster University, Hamilton, Ontario L8S 4K1, Canada. *Restricted linear convolution inequalities and estimates for bilinear convolution operators.* Preliminary report.

We describe an inequality for restrictions of linear convolution operators to subspaces. Applications include estimates for bilinear convolution operators and their maximal operator versions, and bilinear estimates for solutions to the wave equation. (Received July 03, 2012)

1082-42-139 **Leonid Slavin*** (leonid.slavin@uc.edu). *Square functions, trees, and the exponential integral.*

Bellman functions in analysis are native to dyadic settings. Such settings can be generalized to α-trees, which are constructs similar to dyadic grids, but with less rigidity. I will survey some recent Bellman-related work concerning square functions defined on trees, the attending Littlewood–Paley theory, and the exponential integrability of function classes arising in this context.

Parts of the work are joint with V. Vasyunin and A. Volberg (Received July 03, 2012)

1082-42-189 **Eric T Sawyer*** (sawyer@mcmaster.ca), Department of Mathematics, 1280 Main Street, Hamilton, Ontario L8S 4K1, Canada. *The indicator/interval testing characterization of the two weight inequality for the Hilbert transform.*

We present joint work with M. Lacey. C.-Y. Shen and I. Uriarte-Tuero that characterizes when the Hilbert transform H_u maps one locally finite weighted space $L^2(u)$ to another $L^2(v)$. Namely, when the strong A_2 condition holds together with the pair of dual indicator/interval testing conditions: the $L^2(v)$ norm of $H_u(1_E)$ is at most a fixed multiple of the $L^2(u)$ norm of 1_I for all closed subsets E of a finite interval I. This provides a first real variable characterization of the two weight inequality, but leaves open the Nazarov-Treil-Volberg conjecture that it suffices to test over only the cases E=I is an interval. (Received July 07, 2012)

1082-42-194 **Faruk Temur*** (temur1@illinois.edu). *Bilinear restriction estimates.*

Bilinear restriction estimates have been useful in harmonic analysis to make progress on the restriction conjecture and in PDE to understand dispersive equations. An $L^2 \times L^2 \to L^p$ bilinear estimate conjectured by Machedon and Klainerman to these ends was proved for cone by Wolff(except the endpoint) and Tao(endpoint). We will describe how to extend the endpoint result to mixed norms. (Received July 07, 2012)

1082-42-197 **Sanat Upadhyay** (sanat@math.uh.edu), Department of Mathematics, University of Houston, Houston, TX 77204-3008, and **Manos Papadakis*** (mpapadak@math.uh.edu), Department of Mathematics, University of Houston, Houston, TX 77204-3008. *Texture Analysis in 3D for the Detection of Liver Cancer in X-ray CT Scans.* Preliminary report.

We propose a method for the 3D-rigid motion invariant texture discrimination for discrete 3D-textures that are spatially homogeneous. We model these textures as stationary Gaussian random fields. We formally develop the concept of 3D-texture rotations in the 3D-digital domain. We use this novel concept to define a 'distance' between 3D-textures that remains invariant under all 3D-rigid motions of the texture. This concept of 'distance' can be used for a monoscale or a multiscale setting to test the 3D-rigid motion invariant statistical similarity of stochastic 3D-textures.

We use this 'distance' to define a set of 3D-rigid motion invariant texture features. We experimentally establish that when they are combined with mean attenuation intensity differences the new augmented features are capable of discriminating normal from abnormal liver tissue in arterial phase contrast enhanced X-ray CT-scans with high sensitivity and specificity. To extract these features CT-scans are processed in their native dimensionality. We experimentally observe that the 3D-rotational invariance of the proposed features improves the clustering of the feature vectors extracted from normal liver tissue samples. This work is joint with R. Azencott, G. Gladish, S. Jain, and I.A. Kakadiaris. (Received July 07, 2012)

43 ► Abstract harmonic analysis

1082-43-29 **Keith F. Taylor*** (kft@mathstat.dal.ca), **Mahya Ghandehari** and **Aizhan Syzdykova**. *A 4D Wavelet Transform.*

The space $M_n(\mathbb{R})$ of $n \times n$-real matrices is an algebra over $\mathbb{R}$ with an identity. The group of invertible elements of $M_n(\mathbb{R})$ is $GL_n(\mathbb{R})$. In analogy with the affine group of $\mathbb{R}$, we form $G = M_n(\mathbb{R}) \rtimes GL_n(\mathbb{R})$, where $M_n(\mathbb{R})$ is considered as a group under addition and the action of $GL_n(\mathbb{R})$ on $M_n(\mathbb{R})$ is simply matrix multiplication. As a

group, $M_n(\mathbb{R})$ can be identified with $\mathbb{R}^{n^2}$. For $h \in GL_n(\mathbb{R})$, let $\delta(h) = |\det(h)|^n$. For $[x,h] \in G$, define a unitary operator $\rho[x,h]$ on $L^2(\mathbb{R}^{n^2})$ by, for $g \in L^2(\mathbb{R}^{n^2})$, $\rho[x,h]g(y) = \delta(h)^{-1/2} g(h^{-1}(y-x))$, for all $y \in \mathbb{R}^{n^2}$. Then ρ is a single irreducible, square integrable, representation of G that constitutes almost all of $\widehat{G}$ in a certain sense. From ρ one extracts a theory of a continuous wavelet transform which reduces to the classical theory when $n = 1$ and provides an isotropic continuous wavelet transform for $\mathbb{R}^4$ when $n = 2$. In response to the growing need for useful methods of processing 4D data, we present details of the $n = 2$ case. (Received May 15, 2012)

1082-43-105 **Gestur Olafsson*** (olafsson@math.lsu.edu), Department of Mathematics, Louisiana State University, Baton Rouge, LA 70803, and **Jens Christensen** and **Azita Mayeli**. *Besov Spaces and Frames on Stratified Lie Groups.*

We will start by some general fact about harmonic analysis on stratified Lie groups. Then describe the basic ideas behind Coorbit spaces and the role of representation theory in construction of Banach spaces of functions or distributions. Then we apply those ideas to describe homogeneous Besov spaces on stratified Lie groups and their description in terms of frames. (Received June 30, 2012)

1082-43-191 **Palle E. T. Jorgensen*** (palle-jorgensen@uiowa.edu), Math, MLH, University of Iowa, Iowa City, IA 52242. *Trends in Abelian and non-Abelian harmonic analysis.*

With view towards research of Daryl Geller, the presentation will offer a look-back on such areas of Abelian and non-Abelian harmonic analysis as direct integral theory for unitary representations of Lie groups G. The second part will look to the future. In order to address such questions as hypo-ellipticity of second order invariant partial differential operators on G, this will include both the representations themselves and their differentiated forms, i.e., the associated representations of the enveloping algebra of the Lie algebra of G. Special focus will be the cases of G nilpotent, and G solvable. With a view towards more recent research, we will suggest approaches to wavelet analysis in this setting of non-Abelian analysis. Finally, with view to future research, we will suggest this as framework multi-resolution analyses. (Received July 07, 2012)

44 ► Integral transforms, operational calculus

1082-44-89 **Boris Rubin*** (borisr@math.lsu.edu), Department of Mathematics, Lockett Hall, Louisiana State University, Baton Rouge, LA 70803. *Weighted L^p estimates for the k-plane transforms.*

The k-plane transform R_k takes functions on $\mathbb{R}^n$ to functions on the Grassmann manifold $G(n,k)$ of affine k-dimensional planes in $\mathbb{R}^n$, $0 < k < n$. The more general "j-plane to k-plane" transform $R_{j,k}$ takes functions on $G(n,j)$ to functions on $G(n,k)$, $0 \le j < k < n$. Both mappings are defined in a standard way by integration with inclusion. We obtain sharp weighted norm estimates for the operators R_k and $R_{j,k}$ acting on the corresponding L^p spaces with the radial weight, which is a power function of the Euclidean distance from the plane (or point) to the origin. The admissible set of all such weights is characterized and the norm of the operators R_k and $R_{j,k}$ is explicitly computed.

The results can be transferred to totally geodesic Radon transforms in the hyperbolic and elliptic spaces. (Received June 27, 2012)

1082-44-93 **Gaik Ambartsoumian**, **Venkateswaran P. Krishnan** and **Eric Todd Quinto*** (todd.quinto@tufts.edu), Dept. of Mathematics, Tufts University, 503 Boston Ave., Medford, MA 02155. *The Microlocal Analysis of a Local Bistatic Ultrasound Algorithm.*

The speaker will describe a problem in bistatic ultrasound that reduces to integrals over ellipses with foci a fixed distance apart. In this problem, the foci rotate around a circle and the goal is to reconstruct the structure of an object inside the circle. The microlocal analysis of this transform will be given and the reconstruction operator will be shown to be an elliptic pseudodifferential operator. Finally, the speaker will show reconstructions by his senior honors thesis student, Howard Levinson, that show all singularities of the object. (Received June 27, 2012)

46 ► Functional analysis

1082-46-215 **Richard M Aron*** (aron@math.kent.edu), Department of Mathematics, Kent State University, Kent, OH 44242. *Cluster value theorems for certain H^∞ algebras of holomorphic functions on the ball of a Banach space.* Preliminary report.

We present a slight advance on the problem of obtaining a "poor man's version" of the Carleson Corona Theorem for complex-valued H^∞ functions on the open ball B_X of a complex Banach space X. After showing the relation between cluster value theorems for H^∞ spaces and the Corona theorem, we will review the proof of the cluster valued theorem for $H^\infty(B_{c_0})$ (with D. Carando, T. W. Gamelin, S. Lassalle, and M. Maestre in [Math. Ann. **353** (2012), 293-303]). We will also show that the method of proof works for certain subalgebras of $H^\infty(B_X)$ for X other than c_0.

Despite the logical conclusion that can be drawn from reading the previous paragraph, the talk will be expository and accessible. (Received July 08, 2012)

1082-46-263 **Bonnie C. Jacob*** (bcjntm@rit.edu). *Choice of an optimal source in optical tomography: a special case and alternative formulation.*

Optical tomography is an imaging modality that has significant appeal in medical applications because of its non-invasive nature. However, the ill-posedness of the problem makes optical tomography difficult to use in practice.

To combat this problem, we have worked on developing a method to choose a source that makes the problem as well posed as possible. The process depends on the choice of spaces, which we consider as well.

In this talk, I will outline our approach in choosing an optimal source. As an illustration, I will describe steps toward analytically determining an optimal source in a special case. Finally, I will describe a graph theoretic version of the problem. (Received July 09, 2012)

1082-46-272 **Antonio J. Guirao**, IUMPA, Universidad Politecnica de Valencia, 46022 Valencia, Spain, and **Olena Kozhushkina*** (okozhush@math.kent.edu), Department of Mathematical Sciences, Kent State University, Kent, OH 44240. *The Bishop-Phelps-Bollobás property for numerical radius in $l_1(\mathbb{C})$ and $c_0(\mathbb{C})$.*

The classical Bishop-Phelps theorem states that the set of norm attaining functionals is dense in the dual of a Banach space. The quantitative improvement of this statement, the Bishop-Phelps-Bollobás theorem, approximates both the functionals and the points at which they almost attain their norms by, respectively, norm attaining functionals and the points at which they attain their norms. We show that the set of bounded linear operators from a Banach space X to X admits a Bishop-Phelps-Bollobás type theorem for numerical radius whenever X is $l_1(\mathbb{C})$ or $c_0(\mathbb{C})$. As an essential tool for the proof of this result, two constructive versions of the Bishop-Phelps-Bollobás theorem for $l_1(\mathbb{C})$ are obtained. (Received July 09, 2012)

1082-46-316 **David R Larson*** (larson@math.tamu.edu), Department of Mathematics, Texas A&M University, College Station, TX 7783. *Continuous frames and operator valued-measures.* Preliminary report.

We present some new results and discuss some open problems concerning the dilation theory of continuous frames and the relationship with operator-valued systems of imprimitivity. This represents joint work with Deguang Han and Rui Liu. (Received July 10, 2012)

47 ► Operator theory

1082-47-94 **Flavia Colonna*** (fcolonna@gmu.edu), Dept. of Mathematical Sciences, George Mason University, 4400 University Drive, Fairfax, VA 22030, and **Maria Tjani**. *Weighted composition operators from the analytic Besov spaces into the weighted-type space H^∞_μ.*

Let μ denote a positive continuous function on the open unit disk $\mathbb{D}$. In this work, we characterize the bounded weighted composition operators from the analytic Besov spaces B_p $(1 \leq p < \infty)$ into the weighted-type space H^∞_μ consisting of the analytic functions on $\mathbb{D}$ such that $\sup_{z\in\mathbb{D}} \mu(z)|f(z)| < \infty$ and determine their operator norm. We also determine the essential norm of the bounded weighted composition operators acting on the Dirichlet space and obtain estimates when $p = 1$. In the general case when the operator maps B_p into H^∞_μ, we derive an approximation of the essential norm that yields a characterization of the compact weighted composition operators. Finally, we derive characterizations of the bounded and the compact weighted composition operators

from the spaces of antiderivatives of functions in B_p and $BMOA$ into the α-Bloch spaces. (Received July 05, 2012)

1082-47-96 **Yueshi Qin** (yqin@albany.edu), Dept. of Mathematics and Statistics, SUNY at Albany, Albany, NY 12222, and **Rongwei Yang*** (ryang@albany.edu), Dept. of Mathematics and Statistics, SUNY at Albany, Albany, NY 12222. *Beurling-Lax theorem in the Hardy space over the bidisk.*

Let $H^2(E)$ denote E-valued Hardy space over the unit disk D, where E is a complex Hilbert space of any dimension. If S is multiplication of functions in $H^2(E)$ by coordinate function z, then S is often called a unilateral shift. Invariant subspaces of S, which play central roles in Nagy-Foias model theory, are characterized in terms of inner functions by Beurling's theorem in multiplicity 1; and in terms of operator-valued inner functions by Beurling-Lax theorem in higher multiplicities. The Hardy space over the bidisk $H^2(D^2)$ is a particular form of $H^2(E)$, and it has some good examples of invariant subspace of S. For two of the examples, their corresponding operator-valued inner functions turn out to be strikingly simple. (Received June 28, 2012)

1082-47-98 **Zeljko Cuckovic*** (zcuckovi@math.utoledo.edu), University of Toledo, Department of Mathematics, 2801 W. Bancroft St., Toledo, OH 43606, and **Sonmez Sahutoglu**, University of Toledo, Department of Mathematics, 2801 W. Bancroft St., Toledo, OH 43606. *Compactness of products of Hankel operators on convex domains.*

In this talk we will discuss compactness of products of Hankel operators on the Bergman space of a convex Reinhardt domain in C^2. (Received June 28, 2012)

1082-47-170 **Patrick Cade*** (pcade@siena.edu), Siena College, 515 Loudon Road, Loudonville, NY 12211, and **Rongwei Yang**. *Projective Spectrum and Cyclic Cohomology (Preliminary Report).* Preliminary report.

For a tuple $A = (A_1, A_2, \ldots, A_n)$ of elements in a unital topological algebra $\mathcal{B}$, the projective spectrum, $P(A)$ is the set of $z \in \mathbb{C}^n$ such that the linear pencil $A(z) = z_1A_1 + z_2A_2 + \cdots + z_nA_n$ is not invertible in $\mathcal{B}$. The Maurer-Cartan type $\mathcal{B}$-valued one-form $\omega_A := (A(z))^{-1}dA(z)$ appears to contain much information about the tuple A. Here, ω_A will establish a Jacobi type formula in the finite dimensional case. Furthermore, ω_A gives rise to a map between the cyclic cohomology, $HC^*(\mathcal{B}_A)$ and the de Rham cohomology of the projective resolvent $H^*_d(P^c(A))$. (Received July 06, 2012)

1082-47-240 **Katie Spurrier Quertermous*** (querteks@jmu.edu), Department of Mathematics and Statistics, MSC 1911, James Madison University, Harrisonburg, VA 22807. *C*-algebras Generated by Composition Operators on a Weighted Bergman Space.*

If φ is an analytic self-map of the unit disk $\mathbb{D}$ and $\alpha > -1$, then the composition operator C_φ is a bounded operator on the weighted Bergman space $A^2_\alpha(\mathbb{D})$. We are particularly interested in composition operators induced by linear-fractional self-maps of $\mathbb{D}$ that are not automorphisms of $\mathbb{D}$. In this talk, we will investigate the structures of C*-algebras of operators on $A^2_\alpha(\mathbb{D})$ that are generated by composition operators of this form and the ideal of compact operators. We will compare the results obtained in the weighted Bergman space setting with known results for C*-algebras generated by composition operators acting on the Hardy space $H^2(\mathbb{D})$. (Received July 09, 2012)

1082-47-274 **Nina Zorboska*** (zorbosk@cc.umanitoba.ca), Department of Mathematics, University of Manitoba, Winnipeg, Manitoba R3T 2N2, Canada. *Composition Operators on the Family of Bloch-type Spaces.* Preliminary report.

Composition operators provide a special tool for connections between operator theory, complex analysis and functional analysis. We will talk about several properties of the composition operators on the family of Bloch-type spaces, and the corresponding geometric properties of several different types of inducing functions. (Received July 09, 2012)

1082-47-321 **Gabriel T Prajitura*** (gprajitu@brockport.edu). *Stability of orbital behaviour under invertion and adjoining.* Preliminary report.

We will discuss the connections (or the lack of) between the orbital behaviour of an invertible operator and the orbital behaviour of its inverse. We will also discuss the connections (or the lack of) between the orbital behaviour of an arbitrary operator and the orbital behaviour of its adjoint. (Received July 10, 2012)

1082-47-326 **Quanlei Fang** and **Jingbo Xia*** (jxia@acsu.buffalo.edu), Department of Mathematics, State University of New York at Buffalo, Buffalo, NY 14260. *A hierarchy of von Neumann inequalities?*

The well-known von Neumann inequality can be interpreted as saying that the tuple $(M_{z_1}, \dots, M_{z_n})$ on the Drury-Arveson space H_n^2 dominates every other commuting row contraction $(A_1, \dots, A_n)$. We show that a similar domination relation exists among certain pairs of "lessor" row contractions $(A_1, \dots, A_n)$ and $(B_1, \dots, B_n)$. This hints at a possible hierarchical structure among the family of commuting row contractions. (Received July 10, 2012)

1082-47-328 **Jasbir Singh Manhas** and **Ruhan Zhao*** (rzhao@brockport.edu), Department of Mathematics, SUNY Brockport, Brockport, NY 14420. *New estimates of essential norms of weighted composition operators between Bloch type spaces.*

We give estimates of essential norms of weighted composition operators uC_φ between different Bloch type spaces in terms of the n-th power of φ. We also give similar characterizations for boundedness and compactness of uC_φ between different Bloch type spaces. (Received July 10, 2012)

49 ► Calculus of variations and optimal control; optimization

1082-49-201 **FEISHE CHEN*** (fchen05@syr.edu), 215 Carnegie Hall, Department of Mathematics,Syracuse University, Syracuse, NY 13244. *Proximity Algorithms for Total Variation Based Image Deblurring.*

In this talk, I will present my recent work on solving a general problem of the following form:

$$\min_{x\in\mathbb{R}^n} \{F(x) = f_1(\mathcal{A}_1 x) + f_2(\mathcal{A}_2 x)\}, \tag{1}$$

where $\mathcal{A}_i, i = 1, 2$ are some matrices and f_1, f_2 are proper, l.s.c., convex functions. This general problem covers a large range of problems in image processing, i.e., denoising, deblurring and so on.

Different from some existing work, this work does not impose assumption on the property of the matrices and the boundary extension of the data theoretically. To find a solution to this general problem, iterative algorithms have been developed. In each iterate, every update of the variables has closed form and can be efficiently computed as long as the proximity operators of f_1, f_2 and the matrix-vector multiplication can be computed fast. Also, convergence of the algorithms can be guaranteed understand certain conditions.

Finally, we apply the proposed algorithms to solve the L2-TV and L1-TV deblurring problems. Numerical results show that the proposed iterative procedures can recover the underlying images with competitive quality compared to some state-of-art algorithms. (Received July 08, 2012)

1082-49-204 **Fabio Raciti*** (fraciti@dmi.unict.it), Depart. of math. and comp. sc., V.le A. Doria, 6, 95125, Catania, Italy, Catania, 95125. *Nash equilibrium and Lagrange multipliers in infinite dimension.*

In this talk we study a class of generalized Nash equilibrium problems and characterize the solutions which have the property that all players share the same Lagrange multipliers. Nash equilibria of this kind were introduced by Rosen in 1965, in finite dimenional spaces. In order to obtain the same property in infinite dimension we use very recent developments of a new duality theory. In view of its usefulness in the study of time-dependent or stochastic equilibrium problems an application in Lebesgue spaces is given. (Received July 08, 2012)

1082-49-212 **Joachim Gwinner*** (joachim.gwinner@unibw-muenchen.de). *Approximation and Regularization Methods for Some Nonsmooth Variational Problems in Continuum Mechanics.*

In this talk we report on recent progress in the numerical treatment of various nonsmooth boundary value problems in continuum mechanics, including unilateral contact with Tresca friction and nonmonotone adhesion/delamination problems. The contribution is based on the recent papers [1, 2] of the author and the recent PhD Thesis [3] of N. Ovcharova written under his guidance.

References

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[2] J.Gwinner, " hp-FEM convergence for unilateral contact problems with Tresca friction in plane linear elastostatics",20 p.,2012,submitted.

[3] N. Ovcharova, *Regularization Methods and Finite Element Approximation of Some Hemivariational Inequalities with Applications to Nonmonotone Contact Problems*, Ph.D. Thesis, 2012.

(Received July 08, 2012)

1082-49-223 **Andrzej Krol*** (krola@upstate.edu), Department of Radiology, SUNY Upstate Medical, Syracuse, NY 13210, **Si Li** (reesiloveu@163.com), Guangdong Province Key Lab of Computational S, School of Mathematics and Computational Sci, Sun Yat-sen University, Guangzhou, 510275, **Lixin Shen** (lshen03@syr.edu), Department of Mathematics, Syracuse University, Syracuse, NY 13244, and **Yuesheng Xu** (yxu06@syr.edu), Department of Mathematics, Syracuse University, Syracuse, NY 13244. *Implementation of Preconditioned Alternating Projection Algorithm (PAPA) for Maximum a Posteriori Emission Computed Tomography Reconstruction.*

We propose a preconditioned alternating projection algorithm (PAPA) for solving the maximum a posteriori (MAP) emission computed tomography (ECT) reconstruction problem as a constrained convex optimization problem with the total variation (TV) regularization. We show that the solution satisfies a system of fixed-point equations defined in terms of 2 proximity operators stemming from the convex functions that define the TV-semi-norm and the constrain involved in the problem. It leads to an alternating projection algorithm. We prove theoretically its convergence. We introduce to PAPA a dynamic EM-preconditioner. We compare PAPA with a conventional MAP expectation-maximization (MAP-EM) algorithm with TV regularizer (EM-TV) and performance of the recently developed nested EM-TV algorithm for ECT reconstruction. Based on the numerical experiments performed in this work, we observe that the alternating projection algorithm with the EM-preconditioner outperforms significantly the benchmark EM-TV in all aspects including the convergence speed, the noise in the reconstructed images and the image quality. It also outperforms the nested EM-TV in the convergence speed while providing comparable image quality. The PAPA algorithm might allow ECT scans with lower radiation dose to patients. (Received July 09, 2012)

1082-49-225 **Noore Zahra*** (noor_zahra_india@yahoo.co.in), School of Engineering and Technology, Sharda University, Gr.Noida, U.P. 201306, India. *Inverse Problems in Brain Image Analysis.*

Imaging techniques are optimal tool for the analysis of human brain. Preclinical and biological research is driven by imaging techniques and image data. Inverse problems involve estimating data or parameter from inadequate observations. The observations are often noisy and contain incomplete information about the brain parameter or data due to the limitations of the measurement devices. Due to lack of information in the indirect observation solution to inverse problems are typically non unique. To tackle this ambiguity of inverse problems solution it is required to incorporate into our estimation prior information about the structure of desired set. In this talk we formulate solution to deconvolution and inverse haftoning for brain images. We will also discuss curvelet transform for inverse problems in brain analysis. (Received July 09, 2012)

1082-49-228 **Erin R Crossen*** (erc7690@rit.edu), 1198 Judge Rd, Basom, NY 14013. *Equation Error Approach for the Inverse Problem of Tumor Identification.* Preliminary report.

Equation error approach was used to recover variable Lamé parameters of incompressible material. Numerical results will be presented. (Received July 09, 2012)

1082-49-246 **Brian C Winkler*** (bcw9368@rit.edu), 6701 Miller Rd, Newark, NY 14513. *A Modified Output Least Squares Approach for the Inverse Problem of Tumor Identification.* Preliminary report.

A novel modified output least squares objective (MOLS) functional is presented in the inverse problem of recovering Lamé parameters for an incompressible or nearly incompressible material. This method has an application to the problem of identifying likely tumor sites within the human body. Subsequent numerical results are also presented. (Received July 09, 2012)

1082-49-264 **Baasansuren Jadamba***, Center for Applied and Computational Math., School of Mathematical Sciences, 85 Lomb Memorial Drive, Rochester, NY 14623. *Regularization of Stochastic Variational Inequalities and a Comparison of an L_p and a Sample-Path Approach.*

In this talk we discuss regularization results of stochastic variational inequalities and a comparison of two numerical approaches for these problems. (Received July 09, 2012)

1082-49-270 **Aydar Uatay*** (abu5981@rit.edu), School of Mathematical Sciences, 85 Lomb Memorial Drive, Rochester, NY 14623. *A multilevel model correction method for inverse problems in linear elasticity.* Preliminary report.

This talk will focus on a modified-output least squares for the identification of certain material parameter in linear elasticity by using a multilevel model correction method. The multilevel method is applied iteratively so that the major computational work is carried out on a sequence of nested coarse grids. Numerical experiments are given to show the efficiency of the approach. (Received July 09, 2012)

1082-49-293 **Hongqi Xue*** (hongqi_xue@urmc.rochester.edu), Department of Biostatistics and Computational, Rochester, NY. *Parameter estimation for ordinary differential equation models with applications in HIV dynamics.*

We consider estimation of constant and time-varying coefficients in nonlinear differential equation (ODE) models with measurement errors. We investigate the nonlinear least squares (NLS) estimation method. Though NLS is the most popular method developed for estimating the parameters in ODE models, so far the NLS estimators and their asymptotic properties have not been systematically studied. We establish the statistical theoretical basis for such NLS estimation with consideration of both numerical errors and measurement errors. We provide guidance in selecting the step size for numerical evaluations of ODEs. Since the NLS method has some drawbacks such as high computational cost, instability and convergence problems, alternative estimation methods have to be developed in order to avoid numerically solving the differential equations directly. We propose a novel class of two-stage smoothing estimation methods and obtain their asymptotic properties. In the first stage, we apply a penalized-spline approach to estimate the state variables, and then in the second stage we exploit the numerical discretization algorithms for an ODE solver to formulate estimating equations. We illustrate these methods with both simulation studies and clinical data on HIV viral dynamics. (Received July 10, 2012)

1082-49-295 **Nathan C Bush*** (ncb2494@rit.edu). *Solving the Inverse Parabolic Problem of Recovering Implied Local Volatility.* Preliminary report.

Options are financial instruments that allow the buyer or seller to hedge risk associated with their investments. To correctly price an option it is essential to know the true local volatility of the underlying investment. Since current volatility is not directly observable in the market, it is necessary to use mathematical techniques to recover 'implied volatility'. The Black-Scholes option pricing model provides a structure for the inverse problem that allows us to recover implied volatility but which is ill-posed. This makes identifying the volatility from real market data a more difficult task. However, the problem can be made well-posed and the implied volatility can be recovered with the use of regularization methods and advanced numerical techniques. Recently, this problem has been successfully investigated in the framework of inverse problems of identifying a variable parameter in a parabolic partial differential equation. This talk will address the underlying mathematical structure of the inverse problem and present preliminary numerical results along with their financial interpretation. (Received July 10, 2012)

1082-49-301 **Emily Bartha***, School of Mathematical Sciences, 85 Lomb Memorial Drive, Rochester, NY 14623, and **Patricia Ann Clark** (pacsma@rit.edu), School of Mathematical Sciences, 85 Lomb Memorial Drive, Rochester, NY 14623. *A Model for the Feasibility of the Control of the Spread of AIDS in South Africa.* Preliminary report.

Over the past few decades, HIV has become a monumental problem facing Sub-Saharan Africa, taking over a million lives per year and drastically hindering the quality of life of its inhabitants. Recently, new field tests have suggested that antiretroviral drugs commonly used to treat AIDS can also provide an effective a preventative measure. Although some have elevated this discovery as the answer to ending the HIV epidemic, many point out the many limitations to treatment as prevention, including the viability of large-scale implementation and the large cost of such an intervention. Mathematical modeling can be enormously in determining a cost effective combination of treatment and prevention measures. This model treats a system of differential equations, which is used to assess the relation of the level of treatment to reduction of the level of infection (Received July 10, 2012)

1082-49-323 **Selin Sariaydin***, School of Mathematical Sciences, Rochester, NY. *On some variational inequality based iterative methods for inverse problems.*

In this talk we will study the inverse problem of identifying variable parameters in partial differential equation by using variational inequality approach. Extragradient methods, proximal point methods and some continuous methods will be discussed. (Received July 10, 2012)

1082-49-324 **Benjamin Parker***, School of Mathematical Sciences, Rochester Institute of Technology, Rochester, NY. *A comparison of various numerical optimization approaches for solving inverse problems.*

In this talk we will compare the numerical performance of several known numerical optimization methods to solve the inverse problem of parameter identification. (Received July 10, 2012)

51 ► Geometry

1082-51-25 **Nick Sheridan*** (nicks@math.mit.edu). *Homological mirror symmetry.*

Mirror symmetry is a conjectural relationship between complex and symplectic geometry, and was first noticed by string theorists. Mathematicians became interested in it when string theorists used it to predict counts of curves on the quintic three-fold (just as there are famously 27 lines on a cubic surface, there are 2875 lines on a quintic three-fold, 609250 conics, and so on). Kontsevich, in his 1994 ICM address, conjectured that mirror symmetry should reflect an equivalence of categories: this is his celebrated 'Homological Mirror Symmetry' conjecture. Most of the talk will be an overview of mirror symmetry with a focus on the symplectic side, leading up to Kontsevich's conjecture. Finally I will describe a proof of Kontsevich's conjecture for the quintic three-fold, and more generally for a Calabi-Yau hypersurface in projective space of any dimension. I will draw many pictures in the one-dimensional case. (Received May 09, 2012)

1082-51-162 **Emmy Murphy*** (mlmurphy@stanford.edu). *Lagrangian Caps in $\mathbb{C}^2$.*

Given the standard contact structure on $S^3 \subseteq \mathbb{C}^2$, a smooth knot K is called Legendrian if the vector field $i\frac{dK}{dt}$ is tangent to S^3 everywhere. We study how exact Lagrangians in $\mathbb{C}^2$ interact with Legendrian knots in S^3. Because there is no symplectomorphism of $\mathbb{C}^2 \setminus \{0\}$ exchanging the inside and the outside, an exact Lagrangian surface in $B^4 \subseteq \mathbb{C}^2$ with boundary K will have very different properties than an exact Lagrangian surface in $\mathbb{C}^2 \setminus B^4$ with boundary K. We call the former a *Lagrangian filling*, and the latter a *Lagrangian cap*. We discuss various results on the interactions between symplectic topology and knot theory, focusing on a recent theorem which states that any Legendrian knot admits a Lagrangian cap after sufficient stabilization. (Received July 05, 2012)

1082-51-181 **Hengyu Zhou*** (hzhou@gc.cuny.edu), The Graduate Center, CUNY, 365 Fifth Avenue, New York, NY 10016. *Curve's graphic mean curvature flow.*

We generalize M.-T. Wang (2002)work about long existence and convergence for solutions of graphic mean curvature flow in arbitrary codimension into the curve's case. We conclude for any smooth closed curve c in compact manifold N, the mean curvature flow of the graph in $S^1 \times N$ exists for infinity and converges to a geodesic of the product manifold. In another words, the projection of mean curvature flow into N is always a curve and finally converges into a point or a geodesic in N. (Received July 10, 2012)

1082-51-238 **Max Lipyanskiy*** (mlipyan@math.columbia.edu). *Gromov-Uhlenbeck Compactness.*

We introduce an analytic framework that, in special circumstances, unites Yang-Mills theory and the theory of pseudoholomorphic curves. As an application of these ideas, we discuss the relation between instanton Floer homology and Lagrangian Floer homology of representation varieties. (Received July 09, 2012)

53 ► Differential geometry

1082-53-3 **Dusa McDuff*** (dusa@math.columbia.edu). *Embedding questions in symplectic geometry.*

Gromov's work on the nonsqueezing problem showed that embedding questions lie at the heart of symplectic geometry. This talk will discuss a variety of these questions, mostly in four dimensions. It is aimed at a general audience, and will not assume prior knowledge of symplectic geometry. (Received March 13, 2012)

1082-53-20 **Guofang Wei** and **Peng Wu*** (wupenguin@math.ucsb.edu), Department of Mathematics, University of California, Santa Barbara, Santa Barbara, CA 93106. *On volume growth of gradient steady Ricci solitons.*

We study volume growth of gradient steady Ricci solitons. We show that if the potential function of a gradient steady Ricci soliton satisfies a uniform decay condition, then the soliton has at most Euclidean volume growth. (Received June 22, 2012)

1082-53-81 **Ovidiu Munteanu***, University of Connecticut, Storrs, CT 06269, and **Jiaping Wang**, University of Minnesota, Minneapolis, MN 55455. *Smooth metric measure spaces.*

We present recent development in the theory of smooth metric measure spaces. We plan to discuss geometric and analytical aspects such as volume growth, spectral estimates, function theory and structure at infinity. (Received June 25, 2012)

1082-53-142 **Mijia Lai*** (mijialai@gmail.com), 915 Hylan Building, University of Rochester, PO Box 270138, Rochester, NY 14627. *Convergence of J-flow on Kähler surface: a boundary case.*

Given a compact Kähler manifold M of complex dimension 2 with two Kähler metrics ω and χ, J-flow is defined as:

$$\frac{\partial \varphi}{\partial t} = \frac{1}{2} - \frac{\chi_\varphi \wedge \omega}{\chi_\varphi^2}.$$

It is shown by Weinkove that the flow converges smoothly to the stationary point if and only if $[\chi-\omega] > 0$. Later on, Song and Weinkove showed the solution (C^2-norm) must blow up if $[\chi - \omega] > 0$ does not hold. In this talk, we give a more precise convergence picture when χ degenerates to the boundary of the condition $[\chi - \omega] > 0$. As an application, for Kähler surfaces of $c_1(M) < 0$, the cone of the Kähler classes whose Mabuchi energy is proper is enlarged from a peviously known open cone to a new set containing some of its boundary points. This is a joint work with Hao Fang, Jian Song and Ben Weinkove. (Received July 04, 2012)

1082-53-143 **Hung T Tran*** (hungtran@math.cornell.edu). *Estimates on the solutions to the conjugate heat equation.*

Using the framework of monotone formulas, we derive several estimates on solutions to the appropriately adapted conjugate heat equation on certain manifolds (Received July 09, 2012)

1082-53-180 **Tedi Draghici**, **Tian-Jun Li** and **Weiyi Zhang*** (wyzhang@umich.edu), Department of Mathematics, 2074 East Hall, 530 Church Street, Ann Arbor, MI 48109. *Complex geometry of Symplectic 4-manifolds.*

It will be shown that several concepts/properties of algebraic surfaces would still hold for certain symplectic 4-manifolds with tamed almost complex structures. Examples include Dolbeault cohomology, Nakai-Moishezon duality and degenerations of rational curves. (Received July 06, 2012)

1082-53-222 **William Wylie*** (wwylie@syr.edu), 215 Carnegie Building, Mathematics Department, Syracuse University, Syracuse, NY 13244. *Some uniqueness theorems for the Ricci curvature of warped products.*

We will discuss a uniqueness theorem for prescribing the Ricci curvature on a warped product manifold with a fixed base and a space form fiber. The cases of Einstein metrics and gradient Ricci solitons will also be addressed. These theorems come from analyzing an very general over determined system of linear equations involving the hessian of a function on a Riemannian manifold. This is joint work with Chenxu He and Peter Petersen. Time permitting, we may also discuss a uniqueness theorem for gradient Ricci solitons with a fixed potential function within a conformal class, this is joint work with Jeff Jauregui. (Received July 09, 2012)

1082-53-231 **Vinicius Gripp***, viniciusgripp@gmail.com, and **Daniel Cristofaro-Gardiner** and **Michael Hutchings**. *Asymptotics of ECH capacities.*

The Embedded Contact Homology capacities were defined by Michael Hutchings and provide obstructions to symplectic embeddings, which are sharp in some cases. I will talk about a recent result about the asymptotics of these capacities. This is joint work with Daniel Cristofaro-Gardiner and Michael Hutchings. (Received July 09, 2012)

1082-53-278 **Maksim Maydanskiy*** (maksimm@math.stanford.edu) and **Yanki Lekili**. *Floer theoretically essential tori in rational blowdowns.*

We study a family of monotone Lagrangian tori in the Milnor fibre of the complex surface singularity of type A_n. By presenting these Lagrangians as matching tori in a Lefschetz fibration, we compute their Floer homology and conclude that none of them are displaceable. We next study some finite unramified quotients of the A_n Milnor fibre which coincide with the Stein surfaces appearing in Fintushel and Sterns rational blowdown construction. We show that these Stein surfaces have no exact Lagrangian submanifolds. However they do have Floer theoretically essential monotone Lagrangian tori, finitely covered by the monotone tori that we studied in the A_n Milnor fibre. We conclude that these Stein surfaces have non- vanishing symplectic cohomology. (Received July 10, 2012)

1082-53-296 **Ronan J. Conlon***, rconlon@math.mcmaster.ca, and **Hans-Joachim Hein**. *A theorem of existence for Asymptotically Conical Calabi-Yau manifolds.*

Asymptotically Conical (AC) Calabi-Yau manifolds are Ricci-flat Kahler manifolds that resemble a Ricci-flat Kahler cone at infinity. I will describe an existence theorem for AC Calabi-Yau manifolds which, in particular, yields a refinement of an existence theorem of Tian and Yau for such manifolds. Time pending, I will also discuss some examples. This is ongoing work with Hans-Joachim Hein. (Received July 10, 2012)

1082-53-297 **Mihai Bailesteanu*** (bailesteanu@math.rochester.edu), Department of Mathematics, Hylan 801, Rochester, NY 14627. *Spin(7) manifolds.*

We study Spin(7) manifolds, which are 8 dimensional manifolds, that have a cross product on its tangent bundle, which generates a natural 4-form. We discuss some canonical vector fields on these manifolds and some applications. (Received July 10, 2012)

1082-53-317 **Andrew A. Cooper*** (ancoop@math.upenn.edu), Dept of Mathematics, 209 S 33rd Street, Philadelphia, PA 19104. *Finding Isotopies with the Legendre Curve Flow.*

Eliashberg-Fraser showed that two Legendrian unknots are isotopic if their classical invariants (rotation and Thurston-Bennequin numbers) are the same. I will discuss how to find this isotopy with Smoczyk's modified curve-shortening flow. (Received July 10, 2012)

54 ► General topology

1082-54-187 **Benjamin Espinoza*** (bee1@pitt.edu), **Paul Gartside** and **Ana Mamatelashvili**. *n-Arc Connected Spaces.*

A topological space X is called n-arc connected if for any n points $x_1, x_2, \ldots, x_n$ in X there exists an arc α containing $x_1, x_2, \ldots, x_n$. If a space is n-arc connected for all $n \in \mathbb{N}$, then it is called ω-arc connected. A space is called $\aleph_0$-arc connected if for every countable subset S there is an arc containing S. We give a characterization of $\aleph_0$-arc connected continua. (Received July 06, 2012)

1082-54-188 **Paul Gartside**, **Benjamin Espinoza** and **Merve Kovan-Bakan***, University of Pittsburgh, Department of Mathematics, 301 Thackeray Hall, Pittsburgh, PA 15217, and **Ana Mamatelashvili**. *Complexity of Rational ω-sac Continua.*

In this talk, I will introduce the classes of all rational n-sac continua, for $n \in \mathbb{N}$ and $n = \omega$, and show that none of these classes are Borel. (Received July 06, 2012)

1082-54-199 **Ana Mamatelashvili*** (anm137@pitt.edu). *n-Strongly Arc-Connected Graphs and Regular Continua.*

A continuum X is n-strongly arc-connected (n-sac) if for any n points in X there is an arc that goes through these points in order. We will give examples and investigate n-sac-ness of graphs and of regular continua. For graphs, the interesting case to look into is 3-sac-ness and we will give a characterization theorem that follows from an earlier result by Bellamy. Graphs are never 4-sac but for regular continua we will construct spaces with n-sac property for each n and furthermore spaces that are n-sac but not n+1-sac. (Received July 08, 2012)

1082-54-288 **Paul Gartside*** (gartside@math.pitt.edu), **Merve Kovan-Bakan**, **Ana Mamatelashvili** and **Ben Espinoza**. *ω-Strongly Arc Connected Rational Continua Exist.*

A space is said to be ω-strongly arc connected (ω-sac) if for any distinct points $x_1, \ldots, x_n$ in the space there is an arc visiting the points in order.

Plane continua and regular continua are never ω-sac. We construct an example of an ω-sac rational continuum. (Received July 10, 2012)

1082-54-322 **Jorge M Martínez-Montejano*** (jorge@matematicas.unam.mx), **María Elena Aguilera** and **Luis Miguel García-Velázquez**. *Being contractible is not a Whitney reversible property.*

Let $\mathcal{P}$ be a topological property. We say that $\mathcal{P}$ is a strong Whitney reversible property if the following implication holds: if X is a continuum and there is a Whitney map μ for $C(X)$ such that $\mu^{-1}(t)$ has property $\mathcal{P}$ for each $t \in (0, \mu(X))$, then X has property $\mathcal{P}$. We show that being contractible is not a strong Whitney reversible property. (Received July 10, 2012)

57 ► Manifolds and cell complexes

1082-57-153 **Samuel Lisi** (samuel.lisi@ulb.ac.be), Université Libre de Bruxelles, Département de Mathématiques, CP 218 Boulevard du Triomphe, B-1050 Bruxelles, Belgium, **Chris Wendl** (c.wendl@ucl.ac.uk), Department of Mathematics, University College London, Gower Street, London, CA WC1E 6BT, and **Jeremy Van Horn-Morris*** (jvanhorn@math.stanford.edu), Stanford University, Department of Mathematics, 450 Serra Mall, Building 380, Stanford, CA 94305. *Spinal open books and symplectic fillings.* Preliminary report.

A spinal open book decomposition on a contact manifold is a generalization of a supporting open book, which, for example, exists naturally on the boundary of a symplectic filling with a Lefschetz fibration over any compact oriented surface with boundary. We show that when ever a contact 3-manifold admits such a decomposition with a planarity assumption, its symplectic fillings can be classified up to symplectic deformation equivalence in terms of diffeomorphism classes of Lefschetz fibrations. As an example, we characterize precisely which circle bundles with S^1-invariant contact structures are strongly fillable, and show that the fillable ones always have a unique filling. We also use these notions to construct new criteria for algebraic torsion and the vanishing of the ECH contact invariant. (Received July 05, 2012)

1082-57-167 **Elena Pavelescu***, Oklahoma State University, Stillwater, OK 74078, and **Danielle O'Donnol**. *Legendrian $\theta-$graphs.* Preliminary report.

We define the invariants Thurston-Bennequin number, tb, and rotation number, rot , for Legendrian graphs. We determine which triples of integers (tb_1, tb_2, tb_3) and (rot_1, rot_2, rot_3) can be realized as the Thurston-Bennequin number and the rotation number of a Legendrian $\theta-$graph with all unknotted cycles. We investigate whether these invariants determine the graph up to Legendrian isotopy. (Received July 05, 2012)

1082-57-220 **John A. Baldwin** and **Steven Sivek*** (ssivek@math.harvard.edu). *A contact invariant in monopole Floer homology.*

Kronheimer and Mrowka recently used monopole Floer homology to define an invariant of sutured manifolds, following work of Juhász in Heegaard Floer homology. Contact 3-manifolds with boundary are natural examples of such manifolds. In this talk, we will construct an invariant of a contact structure as an element of the associated sutured monopole homology group. We will discuss several interesting properties of this invariant, including gluing maps which are analogous to the Heegaard Floer sutured gluing maps of Honda, Kazez, and Matić, and applications to Legendrian knots. (Received July 09, 2012)

1082-57-221 **Michael Brad Henry*** (mbhenry@siena.edu) and **Dan Rutherford** (drruther@uark.edu). *A combinatorial differential graded algebra for Legendrian knots from generating families.*

We outline recent work that assigns a new differential graded algebra (DGA) to a Legendrian knot in the standard contact structure on R^3. The definition of the DGA is motivated by considering Morse-theoretic data from a generating family. A generating family f_x for a Legendrian knot is a family of functions whose critical values encode a projection of the knot. The DGA is defined combinatorial using an algebraic analogue of a generating family first introduced by Pushkar. We will discuss the motivation and construction of this DGA and relationships between the new DGA and the Chekanov-Eliashberg DGA. As an application, we can use the new DGA to answer the question, "If two augmentations are associated to the same normal ruling, do they necessarily have isomorphic linearized contact homology?" (Received July 09, 2012)

58 ► Global analysis, analysis on manifolds

1082-58-23 **Katrin Wehrheim*** (wehrheim@mit.edu), 77 Mass AVe, Cambridge, MA 02139. *A polyfold proof of the Arnold conjecture.*

In joint work with Peter Albers and Joel Fish we use polyfold technology to prove the Arnold conjecture on the number of periodic orbits of a time-periodic Hamiltonian system. (Received May 08, 2012)

1082-58-156 **Olguta Buse*** (buse@math.iupui.edu), **Richard Hind** and **Emmanuel Opshtein**. *Symplectic ellipsoid embeddings in higher dimensions and packing stability.*

Motivated by a search for strong reccurence properties of symplectic mappings Gromov asked for the maximal sizes of balls for which k disjoint copies can be symplectically embedded simultaneously into a given symplectic manifold. If the total volume of the the balls matches that of the target manifold, one says that they are

volume filling. The symplectic packing stability conjecture, proved in the mid- nineties by Paul Biran for most four dimensional manifolds, states that for all numbers k sufficiently large one can always get a volume filling symplectic k -embedding into a given symplectic manifold. We will establish this conjecture for all symplectic manifolds in four dimensions and for those higher dimensional manifolds with rational cohomology classes. The main tool that we establish and use is the flexibility of symplectic ellipsoid embeddings in all dimensions. This is joint work with Richard Hind and Emmanuel Opshtein. (Received July 09, 2012)

1082-58-209 **Pierre Albin*** (palbin@illinois.edu), **Clara Aldana** and **Frederic Rochon**. *Compactness of relatively isospectral sets of surfaces.*

Although one can not 'hear the shape of a drum', it turns out that the set of isospectral metrics on a closed surface forms a compact set. I will discuss joint work with Clara Aldana and Frédéric Rochon regarding the corresponding statement for non-compact surfaces. (Received July 08, 2012)

1082-58-284 **Mohamed Mokhtar Elshrif*** (melshrif77@gmail.com), 304 Crittenden Way, Apt#3, Rochester, NY 14623, and **Elizabeth M. Cherry**. *Assessing the Behavior of Models of Human Ventricular Cardiac Electrophysiology in Tissue.*

We analyze the dynamics of two recently developed models of human ventricular cell electrophysiology, the Grandi et al. and O'Hara et al. models, in 0d, 1d and 2d tissue. Our goals are to understand the range of behavior of these models and their suitability for studying cardiac arrhythmias and to compare them with previous models. We assess different electrophysiological properties, including action potential duration (APD) and shape, rate adaptation of APD and conduction velocity (CV), and existence and magnitude of alternans and short-term memory. In addition, we study the behavior of reentrant waves that underlie arrhythmias. The Grandi et al. model exhibits properties similar to stable ventricular tachycardia whereas the O'Hara et al. model shows different regimes. In comparison, previous models show behavior ranging from stable tachycardia to unstable dynamics unlike both tachycardia and fibrillation. Overall, we find that the Grandi et al. model is better suited for simulating stable arrhythmias with realistic periods and for preserving action potential shapes and CV in tissue, and that the O'Hara et al. model reproduces more closely action potential shapes in single cells along with properties of intracellular calcium, rate dependence, memory, and alternans. (Received July 10, 2012)

60 ► Probability theory and stochastic processes

1082-60-21 **Xiang Yu*** (xiangyumath@gmail.com). *Utility Maximization with Consumption Habit Formation in Incomplete Markets.*

We study the continuous time utility optimization problem with consumption habit formation in general incomplete semimartingale financial markets. Introducing the set of auxiliary state processes and the modified dual space, we embed our original problem into an abstract time-separable utility maximization problem with a shadow random endowment on the product space $\mathbb{L}^0_+(\Omega \times [0,T], \mathcal{O}, \bar{\mathbb{P}})$. We establish existence and uniqueness of the optimal solution using convex duality by defining the primal value function as depending on two variables, i.e., the initial wealth and the initial standard of living. We also provide market independent sufficient conditions both on the stochastic discounting processes of the habit formation process and on the utility function for the well-posedness of our original optimization problem. Under the same assumptions, we can carefully modify the classical proofs in the approach of convex duality analysis when the auxiliary dual process is not necessarily integrable. (Received May 04, 2012)

1082-60-58 **Shannon L Starr*** (sstarr1@gmail.com), UAB Department of Mathematics, Campbell Hall, 1300 University Blvd, Birmingham, AL 35294-117, and **Meg Walters** (walters@math.rochester.edu), UR Department of Mathematics, 917 Hylan Building, RC Box 270138, Rochester, NY 14627. *Fluctuation bounds for the Mallows measure.*

For each positive number q, the Mallows measure on S_n is a probability measure such that the probability of π is proportional to q-to-the-power of the number of inversions of π. Taking a double limit where n converges to infinity and q equals $1 - O(1/n)$ we consider the length of the longest increasing subsequence and bound the fluctuations. (Received June 16, 2012)

1082-60-60 **David Jerison** and **Lionel Levine***, 310 Malott Hall, Ithaca, NY 14853, and **Scott Sheffield**. *Internal DLA and the Gaussian free field.*

Starting with n particles at the origin in the square grid $\mathbb{Z}^2$, let each particle in turn perform simple random walk until reaching an unoccupied site. Lawler, Bramson and Griffeath proved that with high probability the

resulting random set of n occupied sites is close to a disk. We prove a central limit theorem for the martingale defined by summing a discrete harmonic polynomial over this random set. A consequence is that space-time averages of its fluctuations from circularity converge in law to a variant of the Gaussian free field. (Received June 17, 2012)

1082-60-64 **Philip S Griffin*** (psgriffi@syr.edu). *Ruin time for a class of general Lévy insurance risk processes.*

We investigate the behavior of a Lévy process X with convolution equivalent Lévy measure, up to the time of first passage over a high level u. Such problems arise naturally in the context of insurance risk where X represents the excess in claims over premium and u the initial reserve. The time of first passage is called the ruin time. We obtain a precise asymptotic estimate on the probability of ruin in finite time, which may then be used to further study the process conditioned on first passage by time t. (Received June 18, 2012)

1082-60-67 **Jonathon Peterson**, Department of Mathematics, Purdue University, West Lafayette, IN 47907, and **Gennady Samorodnitsky*** (gs18@cornell.edu), School of ORIE, Cornell University, Ithaca, NY 14850. *How do heavy tails express themselves in random environment: weak weak limit theorems.*

We consider a one-dimensional, transient random walk in a random i.i.d. environment. The asymptotic behaviour of such random walk depends to a large extent on a crucial parameter kappa>0 that determines the fluctuations of the process. When 0<kappa<2, the averaged distributions of the hitting times of the random walk converge to a kappa-stable distribution. However, it was shown recently that in this case there does not exist a quenched limiting distribution of the hitting times. That is, it is not true that for almost every fixed environment, the distributions of the hitting times (centered and scaled in any manner) converge to a non-degenerate distribution. We show, however, that the quenched distributions do have a limit in the weak sense. That is, the quenched distributions of the hitting times – viewed as a random probability measure on R – converge in distribution to a random probability measure, which has interesting stability properties. Our results generalize both the averaged limiting distribution and the non-existence of quenched limiting distributions. (Received June 18, 2012)

1082-60-75 **Jianfu Chen**, **Jin Ma** and **Hong Yin*** (hyin@brockport.edu). *Forward-backward Stochastic Differential Equations with Discontinuous Coefficients.*

In this paper we are interested in the well-posedness of a "regime-switching" type of fully coupled forward-backward SDE (FBSDE) in which the forward drift coefficient is piecewise continuous in the backward component of the solution. Such a discontinuity violates the usual continuity assumptions (on the backward variables) of all existing results, and example shows that non-uniqueness can easily happen when the forward diffusion is degenerate even when the monotonicity conditions are in force. In a Markovian setting with non-degenerate forward diffusion, we show that, by the standard mollification method, a decoupling function can still be constructed, and it is a solution to the corresponding quasilinear PDE in the sense of distribution. With such a decoupling function we first show that the FBSDE admits a weak solution in the sense of Antonelli-Ma (2003) and Ma-Zhang-Zheng (2008). We then prove that the pathwise uniqueness holds, whence the strong well-posedness of the FBSDE in the spirit of Yamada-Watanabe Theorem. Our main tool is a comparison result for SDEs with measurable drift based on the so-called Krylov estimates. This problem is motivated by a practical issue in regime-switching term structure interest rate models. (Received June 23, 2012)

1082-60-77 **Laurent Saloff-Coste*** (lsc@math.cornell.edu), Cornell University, Department of Mathematics, Malott Hall, Ithaca, NY 14853-4201, and **Tianyi Zheng**. *Power law random walks on nilpotent groups.*

Let G be a finitely generated nilpotent group equipped with a generating k-tuple S. Fix also a k-tuple of positive reals (each positive real is formally associated to the corresponding generator in S. Our aim is to understand the basic behavior of the random walk whose basic step can be describe as follows: Pick an element s in S associated with the positive real a, pick an integer m at random according to the symmetric power law on the integer with parameter a (more precisely, the probability of picking m is proportional to m to the power -a-1). Note that, in this general model, the real a depend on the generator s. I will explain what we know about these random walks. (Received June 25, 2012)

1082-60-91 **Paul H Jung*** (pjung@uab.edu) and **Greg Markowsky** (Greg.Markowsky@monash.edu). *Random walks at random times.*

A random walk in random scenery (RWRS) is a collective reward process where a random walker collects a random reward (or scenery) at each site it visits. If the walker visits a site multiple times, it collects the same reward many times thus leading to correlations in the collective reward process. Cohen and Samorodnitsky (2006) studied

a renormalization of RWRS and proposed self-similar, symmetric stable processes, which generalize fractional Brownian motion, as their scaling limits. The limiting processes have self-similarity exponents H>1/alpha.

We consider a modification in which a sign associated to the reward (scenery) alternates upon successive visits. The resulting process is what we call a random walk at random time, and it generalizes the so-called iterated random walk. We will discuss their scaling limits, and in particular, show that the alternating scenery leads to limiting processes which have self-similarity exponents H<1/alpha. (Received June 27, 2012)

1082-60-107 **Carl E Mueller*** (2009@carlm.e4ward.com), Dept. of Mathematics, University of Rochester, Rochester, NY 14627, and **Robert Dalang**. *Multiple points for the Brownian sheet in the critical case.* Preliminary report.

Hitting questions for stochastic processes have a long history, and for Markov processes the key tool is potential theory. Consider whether a given process hits points with positive probability. Evidently, it is harder to hit points in high dimensions, because there is more territory for the process to cover. We are in the critical dimension if the process hits points in lower dimensions, but not in higher dimensions. The critical case is usually the hardest to analyze. Now consider multiparameter processes such as the Brownian sheet. The Brownian sheet has a Markov property, it has been known for some time that the sheet does not hit points in the critical case. After questions about hitting, the next issue is often to study multiple points of the process. Recently it was shown that for the Brownian sheet, double points do not occur in the critical dimension, and some progress was made towards the question of multiple points. In this talk, we describe our result which settles this question by showing that the Brownian sheet does not have multiple points in the critical dimension. (Received June 30, 2012)

1082-60-109 **Jannick P Rolland*** (rolland@optics.rochester.edu), Rochester, NY 14627, **Jinxin Huang**, Rochester, NY 14627, **Matthew Kupinski**, Tucson, AZ 85721, **Eric Clarkson**, Tucson, AZ 85721, and **Kye S. Lee**, Rochester, NY 14627. *Estimation of Tear Film Dynamics with Optical Coherence Tomography and Statistical Decision Theory.* Preliminary report.

Currently, there are about 40 to 60 million Americans suffering from Dry Eye Syndrome (DES); this serious public health problem will worsen with the explosive aging population created by baby boomers, where DES has a high incidence. However, the therapeutics for DES are elusive because our understanding of DES is so elementary, especially the correlation between symptoms and the diagnosis. Unfortunately, a quantitative diagnosis, which is the prerequisite to advance the management of DES, is yet to be realized. We are seeking the next breakthrough in DES management by providing a quantitative diagnosis, with the combination of optical coherence tomography (OCT) imaging and statistical decision theory.

In this paper, we present the mathematical model of a Spectral Domain OCT system coupled with task-based image quality assessment such as tear film thickness estimation. Specifically, we investigate a maximum-likelihood estimator for the quantification of the tear film thickness.

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1082-60-112 **Radka Pickova***, Room 1005 SSW, MC 4690, 1255 Amsterdam Avenue, New York, NY 10027. *Volatility-Stabilized Markets.* Preliminary report.

We consider models which generalize the Volatility-stabilized markets introduced in Fernholz and Karatzas (2005). We show how to construct a weak solution of the underlying system of stochastic differential equations, express the solution in terms of time changed squared-Bessel processes, and argue that this solution is unique in distribution. Moreover, we discuss sufficient conditions for the existence of a strong solution and show that strong relative arbitrage opportunities exist in these markets. (Received July 01, 2012)

1082-60-115 **Ted Cox*** (jtcox@syr.edu), Mathematics Department, Syracuse University, Syracuse, NY 13244. *Convergence of voter model densities on finite graphs.* Preliminary report.

We consider a sequence of voter models ξ_t^n on finite sets $\mathcal{S}_n$, $n = 1, 2, \ldots$, with $|\mathcal{S}_n| \to \infty$. For each n let q_n be an irreducible Markov chain transition matrix on $\mathcal{S}_n$ with stationary probability distribution π_n. The voter model ξ_t^n is a Markov process taking values in $\{0,1\}^{\mathcal{S}_n}$ such that independently at all $x \in \mathcal{S}_n$, $\xi_t^n(x)$ flips to $1-\xi_t^n(x)$ at rate $\sum_{y\in\mathcal{S}_n} q_n(x,y)1\{\xi_t^N(y) \neq \xi_t^n(x)\}$. Given a sequence of positive constants γ_n, the corresponding time-scaled voter model density process is $Y_t^n = \sum_{x\in\mathcal{S}_n} \xi_{t\gamma_n}^n(x)/|\mathcal{S}_n|$.

It is well known that in the mean-field case, $q_n(x,y) = 1/(|\mathcal{S}_n|-1)$ for $x \neq y$, if $\gamma_n = |\mathcal{S}_n|$ then Y^n converges as $n \to \infty$ to the Wright-Fisher diffusion Y, the diffusion on $[0,1]$ which has generator $\frac{1}{2}u(1-u)\frac{d^2}{du^2}$. This

convergence also takes place when $\mathcal{S}_n$ is the d-dimensional torus $[0,n)^d \cap \mathbb{Z}_d$ and $q_n(x,y) = 1/2d$. We give a general condition under which this convergence holds for appropriate γ_n. (Received July 02, 2012)

1082-60-116 **Derek Lougee** and **Benjamin Steinhurst*** (steinhurst@math.cornell.edu). *Bond Percolation on the non-p.c.f. Sierpinski gasket and the hexacarpet.* Preliminary report.

Bond percolation on the standard Sierpinski gasket is known to be trivial due to the bounded vertex degree and large number of small cut sets. For the non-p.c.f. Sierpinski gasket the vertex degrees are unbounded as the approximations refine. By embedding a diamond fractal in the non-p.c.f. gasket we see that $p_c < 1$. By a "thinning" procedure we related percolation on graph approximations to the non-p.c.f. gasket to percolation on the iterated barycentric subdivision of the triangle, whose planar dual is the hexacarpet. By using a duality argument we show that $p_c(hex) > 0$. (Received July 02, 2012)

1082-60-124 **Tim Leung*** (tl2497@columbia.edu), New York, NY 10027. *Risk Management for a Portfolio of Employee Stock Options.*

We study the valuation of a portfolio of employee stock options (ESOs). The ESOs are American-style call options written on the company stock. The ESO holder (employee) is subject to a vesting (no-exercise) period and job termination. Under jump-dffusion price dynamics, we analyze the associated optimal stopping problems, and the cost of the ESO portfolio to the issuing company. (Received July 03, 2012)

1082-60-146 **Hasanjan Sayit*** (hs7@wpi.edu), Department of Mathematical Sciences, 100 Institute Road, Worcester, MA 01609. *Absence of arbitrage in a general framework.*

We provide a sufficient condition for absence of arbitrage in a multi-asset market where simple trading strategies with deterministic delay are allowed. We study the invariance of this new condition under certain transformations. In particular, we show that our sufficient condition is verified by a general class of models. (Received July 04, 2012)

1082-60-149 **Andreas Galanis** and **Daniel Stefankovic*** (stefanko@cs.rochester.edu), Computer Science Department, University of Rochester, Rochester, NY 14627, and **Eric Vigoda**. *Inapproximability of the Partition Function for the Antiferromagnetic Ising and Hard-Core Models.*

Recent inapproximability results of Sly (2010), together with an approximation algorithm presented by Weitz (2006) establish a picture for the computational complexity of approximating the partition function of the hard-core model. Let $L_c(T_D)$ denote the critical activity for the hard-model on the infinite D-regular tree. Weitz presented an FPTAS for the partition function when $L < L_c(T_D)$ for graphs with constant maximum degree D. In contrast, Sly showed that for all $D \geq 3$, there exists $\epsilon_D > 0$ such that (unless RP=NP) there is no FPRAS for approximating the partition function on graphs of maximum degree D for activities L satisfying $L_c(T_D) < L < L_c(T_D) + \epsilon_D$.

We prove the complementary result that for the antiferrogmanetic Ising model without external field that, unless RP=NP, for all $D \geq 3$, there is no FPRAS for approximating the partition function on graphs of maximum degree D when the inverse temperature lies in the non-uniqueness regime of the infinite tree T_D. Our results extend to a region of the parameter space for general 2-spin models. Our proof works by relating certain second moment calculations for random D-regular bipartite graphs to the tree recursions used to establish the critical points on the infinite tree. (Received July 05, 2012)

1082-60-203 **Balint Virag***, University of Toronto. *Eigenvalue distribution of sparse random graphs.*

I will review recent progress on understanding the eigenvalue distribution of of random graphs with tight degree distribution, such as Erdos-Renyi graphs, Galton-Watson trees and percolation clusters in Z^d. (Received July 08, 2012)

1082-60-281 **Olympia Hadjiliadis*** (ohadjiliadis@brooklyn.cuny.edu), 2900 Bedford ave, Brooklyn, NY 11210, and **Hongzhong Zhang** and **Tim Leung**. *The price of a market crash, drawdown insurance and trading algorithms.*

Drawdowns are path-dependent measures of risk. Due to their trend following nature they have been used extensively in the description of market crashes. We evaluate the price of a market crash as measured through drawdowns by considering an investor who wishes to insure herself against the risk of a market crash and does so by purchasing insurance claims against drawdowns. We further examine the fair valuation of drawdown insurance in the possibility of early cancellation and identify optimal cancellation strategies. Moreover, we construct drawdown-based trend following trading algorithms and assess their performance on high frequency data for US treasury bonds and notes sold at auction. It is seen that during regimes of instability drawdown

based algorithms result in a profit while in periods of stability, they do not. We finally draw the connection of drawdown algorithms and cumulative sum (CUSUM) on line detection statistics. (Received July 10, 2012)

1082-60-292 **James E. Marengo*** (jemsma@rit.edu), School of Mathematical Sciences, One Lomb Memorial Drive, Rochester, NY 14623, and **Manuel Lopez**. *An Upper Bound for the Expected Difference Between Order Statistics.*

Suppose we randomly and independently choose numbers X1,X2,...,Xn from the interval(0,1)according to some probability distribution. Now let's put these numbers in ascending order and call the results Y1,Y2,...,Yn. If k is less than l, how large can we make the expected value of the difference Yl- Yk? What is the smallest possible upper bound for this expectation? And which probability distribution minimizes this expectation?

We will answer these questions in this talk, which should be accessible to upper division undergraduate mathematics majors who have had a calculus-based probability course. (Received July 10, 2012)

1082-60-305 **Nathan D Cahill*** (nathan.cahill@rit.edu), Rochester Institute of Technology, 85 Lomb Memorial Drive, Rochester, NY 14623, **Laura Rolston** (lar5267@rit.edu), Rochester Institute of Technology, Rochester, NY 14623, and **Lena Gorelick** (lenagorelick@gmail.com), University of Western Ontario, London, ON N6A 5B7, Canada. *Random Walk Hitting Times for Shape Representations in Image Analysis.* Preliminary report.

Implicit shape representations have been used in a variety of areas of image analysis, including pattern classification, image segmentation, statistical shape modeling, and image registration. In this talk, we review an implicit shape representation based on the expected time for a random walk starting at a point inside the shape to hit the shape boundary. We then describe how this representation can be generalized to handle random walks that start outside the shape boundary. Furthermore, we provide conditioning arguments that yield computational approaches for determining not only the expected hitting times, but in fact the entire distribution of hitting times. (Received July 10, 2012)

62 ► Statistics

1082-62-256 **Brian B Avants*** (stnava@gmail.com), 3600 Market St, Suite 370, Philadelphia, PA 19104. *Sparse matrix decomposition methods in brain mapping.*

Independent component analysis (ICA), principal component analysis (PCA) and, to a lesser degree, non-negative matrix factorization (NMF) are popular dimensionality reduction methods within the medical imaging community. One limitation of such methods is that the derived components can be difficult to interpret due to their global extent. If one is seeking to identify a spatially localized image-based biomarker, or understand the effect of disease on specific brain networks, this limitation can be serious. Fortunately, sparse versions of these methods improve upon interpretability, particularly in the high-dimensional setting. However, sparseness comes at the cost of mathematical clarity on the nature of the decomposition. For instance, most sparse principal components analysis methods sacrifice orthogonality to some degree. Under these circumstances, the differences between sparse versions of methods such as ICA, PCA and NMF need to be reconsidered. We have been exploring the possibility for a computational (if not mathematical) framework that unifies these algorithms. We will present effort toward this framework as well as applications of these methods to prediction and hypothesis testing problems in the domain of structural brain mapping. (Received July 09, 2012)

1082-62-289 **Stacey Levine*** (sel@mathcs.duq.edu), Duquesne University, Pittsburgh, PA, **Katie Heaps**, Duquesne University, **Joshua Koslosky**, University of Minnesota, and **Glenn Sidle**, Duquesne University. *Image Fusion using Gaussian Mixture Models.* Preliminary report.

A number of recent works have demonstrated that using patches, in lieu of pixels, as image features can more effectively perform various techniques such as denoising, deblurring, inpainting and super-resolution. This if often carried out by sparsely representing the images patches in appropriately defined, possibly redundant, dictionaries. Yu, Sapiro, and Mallat showed that a related but more stable solution can be found by estimating the patches using Gaussian Mixture Models (GMMs), particularly when solving ill-posed inverse problems such as deblurring and super-resolution. In this talk we discuss how this GMM approach can be can be used for fusing images of the same field of view, suffering from any or all of the above-mentioned degradations. The fusion model retains many of the nice properties of the single image GMM model such as its equivalence to finding an optimal sparse representation in a PCA dictionary, and can be simply modified to handle spatially

varying features, including geometric features (e.g. edges, smooth regions, and textures) as well as spatially varying noise levels. (Received July 10, 2012)

65 ► Numerical analysis

1082-65-18 **S. Chen** and **J. Ding*** (jiudin@gmail.com), Department of Mathematics, Hattiesburg, MS 39406. *Ulam's Method via Dirac's Delta Function Approach.*

For a piecewise monotonic mapping S from an interval into itself we develop a piecewise constant approximation method for computing an absolutely continuous invariant measure with respect to S. The approach is based on the definition of the corresponding Frobenius-Perron operator that employs Dirac's delta function which will be approximated by pulse functions. We show that the resulting numerical scheme is exactly the classic Ulam's method. Other types of approximations will also be considered for higher order methods. (Received April 10, 2012)

1082-65-125 **Bangti Jin*** (btjin@math.tamu.edu), Department of Mathematics, Texas A&M University, Bloc 615, College Station, TX 77843-3368. *A two-stage method for inverse medium scattering problems.*

In this talk, we shall discuss a novel numerical method for inverse medium scattering in acoustic wave propagation. The method consists of two steps: a first step of detecting the scatterer support by a direct sampling method, and a second step of image enhancement by an innovative application of the nonsmooth Tikhonov regularization. Numerical results for two- and three-dimensional examples will be presented. (Received July 03, 2012)

1082-65-134 **Antonio Leitao*** (acgleitao@gmail.com), Department of Mathematics (MTM/CFM/UFSC), Federal Univ. of St. Catarina, P.O.Box 476, Florianopolis - SC, Brazil. *On iterative regularization methods for ill-posed problems.* Preliminary report.

In this talk we report on two articles published in the journal NFAO concerning iterative methods for solving ill-posed problems.

We aim to discuss some topics in the area of inverse problems that relate to the research interests of Professor Nashed. (Received July 03, 2012)

1082-65-168 **Guohui Song*** (gsong9@asu.edu) and **Anne Gelb**. *Sampling with Localized and Weakly-localized Frames.* Preliminary report.

In several applications, such as magnetic resonance imaging (MRI), data may be collected as a series of non-uniform Fourier coefficients. In this case, standard Fourier reconstruction methods cannot be straightforwardly applied and we shall study it under a more general setting of frames. Specifically, we will seek to establish the practicality of numerical frame approximations.

This is a joint work with Dr. Anne Gelb at Arizona State University. (Received July 06, 2012)

1082-65-183 **Yao Lu*** (yaol@med.umich.edu), Department of Radiology, Ann Arbor, MI 48109. *Improving image quality of digital breast tomosynthesis.*

Digital breast tomosynthesis (DBT) has strong promise to improve sensitivity for detecting breast cancer. DBT reconstruction estimates the breast tissue attenuation using projection views (PVs) acquired in a limited angular range. Because of the limited field of view (FOV) of the detector, the PVs may not completely cover the breast in the x-ray source motion direction at large projection angles. The voxels in the imaged volume cannot be updated when they are outside the FOV, thus causing a discontinuity in intensity across the FOV boundaries in the reconstructed slices, which we refer to as truncated projection artifact (TPA). In this study, we developed a new diffusion-based method to reduce TPAs during DBT reconstruction using the simultaneous algebraic reconstruction technique. (Received July 06, 2012)

1082-65-229 **M. Zuhair Nashed*** (zuhair.nashed@ucf.edu), Department of Mathematics, University of Central Florida, 32143. *Noise Models fo Ill-Posed Problems.*

The standard view of noise in ill-posed problems is that it is either deterministic and small (strongly bounded noise) or random and large(not necessarily small. A new noise model was recently proposed and investigated by Eggermont et al. (see [1] and [2]), wherein the noise is "weakly bounded". Roughly speaking, this means that "local averages" of the noise are small. In this talk we describe this approach and give a precise definition in a Hilbert space setting. We give applications to regularization theory. [1] P. P. B. Eggermont, V. N. LaRiccia and M. Z. Nashed, Inverse Problems, 25 (2009) 115018 (14pp) [2] —, Noise Models for Ill-Posed Problems, in

"Handbook of Geomathematics" (W. Freeded, M. Z. Nashed and T. Sonar, Eds.), pages 741-762, Springer-Veralg, Berlin Heidelberg, 2010. (Received July 09, 2012)

1082-65-252 **Stephan W Anzegruber** and **Patricia K Lamm*** (lamm@math.msu.edu). *Local regularization using nondifferentiable penalty constraints.*

Local regularization,a non-classical method for the solution of ill-posed inverse problems, has been used successfully in a number of applications. Depending on the situation, its advantages include the ability to retain the structure of the original problem (often lost using classical methods) and to allow for fast regularized solution algorithms.

In this talk we discuss recent extensions of the local regularization theory which allow the inclusion of nondifferentiable penalty constraints (e.g., TV, L_1-sparsity, etc.) for linear Fredholm inverse problems, and illustrate with the example of image deblurring. (Received July 09, 2012)

1082-65-279 **Jonas Denißen*** (denissen@mpi-magdeburg.mpg.de), Sandtorstr. 1, 39106 Magdeburg, Germany. *Optimal bounds on the solution of linear time-periodic systems.*

In this talk, we give an overview of the Floquet theory for linear time-periodic (LTP) systems and describe the derivation of bounds for the solution of these systems. Floquet-Lyapunov transformations for linear ordinary differential equations with periodic coefficients are introduced and used and thereby, optimal constants can be determined by the differential calculus for norms of matrix functions. These new optimal bounds mean a theoretical and practical progress for LTP systems and cannot be obtained by the methods employed so far. Numerical results for periodically excited multi-mass vibration systems are shown. (Received July 10, 2012)

1082-65-308 **Jacques Beaumont*** (beaumont@binghamton.edu), Binghamton University, Department of Bioengineering, 85 Murray Hill road, Binghamton, NY 13902. *Iterative methods for the solution of the cardiac Bidomain equations.*

The cardiac Bidomain equations are particularly difficult to integrate because they include processes spanning a wide range of time scales. Specifically calcium release by the ryanodine receptor and associated calcium buffering is 10^3 faster than the other cell processes.

We present a new integration scheme to address this problem The time course of the involved variables, $\zeta(t)$, is represented by Lagrange polynomials $\psi_i(t)$ centered on nodes equally spaced between the interval of integration $[t_0, t_1]$. The underlying ordinary differential equation (ODE) is given by,

$$d\zeta(t)/dt = \mathbf{A}\zeta(t) + l$$

where for a first order expansion $\zeta(t) = \zeta^{(0)}\psi_0(t) + \zeta^{(1)}\psi_1(t)$, $\zeta^{(i)}$: value taken by $\zeta(t)$ at node i. The L_2 norm of the residual

$$r(t) = d\zeta(t)/dt - \mathbf{A}\zeta(t) + l$$

is minimized with respect to $\zeta^{(i)}$. A special factorization exploiting the arrow head topology of $\mathbf{A}$ allows to evaluate $\zeta(t + \Delta t)$ with a single matrix-to-vector multiplication.

Simulation shows this method can capture the calcium transient of cardiac cells with an integration time step of 100 μs (Received July 10, 2012)

1082-65-309 **John T Whelan*** (john.whelan@astro.rit.edu), School of Mathematical Sciences, Rochester Institute of Technology, 85 Lomb Memorial Drive, Rochester, NY 14623. *Gravitational Wave Data Analysis: a Mathematical and Statistical Challenge.*

Efforts are currently underway to make the first direct detection of gravitational waves and initiate the field of gravitational wave astronomy. Analysis of data from gravitational wave detectors involves several challenging problems in mathematics, statistics and signal processing. These include detection of weak signals in much louder instrumental noise, estimation of background rates in the presence of non-Gaussian data, and detection and parameter estimation of signals described by multi-dimensional parameter spaces. I will describe some techniques used to address the challenges of gravitational wave data analysis, which include statistical inference (Bayesian and frequentist), singular value decomposition, and time-frequency analysis. (Received July 10, 2012)

1082-65-311 **Cara D. Brooks*** (cbrooks@fgcu.edu), 10501 FGCU Blvd. South, Fort Myers, FL 33965-6565. *On local regularization methods for solving inverse problems.*

Solutions of linear and nonlinear inverse problems, particularly those with special structure or for which non-smooth solutions are expected, can be effectively reconstructed using *local regularization* methods. Key features of these methods are the utilization of data most relevant to the desired solution and the non-global manner in which regularization is applied. For Volterra problems, these methods retain the causal structure of the original problem (in contrast to classical regularization methods) and lead to fast sequential numerical algorithms to

solve the inverse problem. In this talk, we present some advancements in the theoretical development of local regularization methods, namely convergence results for solving classes of linear and nonlinear Volterra inverse problems and strategies to select the (local) regularization parameter. (Received July 10, 2012)

1082-65-315 **Gunay Dogan*** (gunay.dogan@nist.gov), National Institute of Standards & Technology, 100 Bureau Drive, Stop 8910, Gaithersburg, MD 20899-8910. *Variational shape optimization for image segmentation.*

Image segmentation is the task of finding objects, regions or boundaries in given images. It is a fundamental problem in image processing and many different approaches have been proposed to bridge the gap between a set of discrete measurements and the continuous geometric objects sought in the image (such as curves or surfaces). In the last two decades, energy minimization has been adopted as an effective approach for defining and solving the segmentation problem. In this approach, one designs special segmentation energies and computes the shapes minimizing these energies, thus identifying the object boundaries. This approach turns the segmentation problem into a shape optimization problem. In this talk, I will describe an explicit Lagrangian method, based on a finite element discretization, to perform the shape optimization and locate the objects in images. Realizing a practical method that can handle a diverse set of images efficiently and robustly is challenging. I describe the issues that arise and how we address them using image statistics, well-designed gradient descent velocities, adaptivity and careful control of the discretization errors that arises in different components of the algorithm. I demonstrate the effectiveness of our method with several real examples. (Received July 10, 2012)

1082-65-319 **Mark S Gockenbach*** (msgocken@mtu.edu) and **Kaylee M Walsh**. *Multiplicative regularization for linear inverse problems.*

Multiplicative regularization is a strategy for solving a linear ill-posed problem by minimizing the product of the norm of the data misfit and the norm (or seminorm) of the model. Although this technique is presented as independent of the need to choose a regularization parameter, it turns out to be equivalent to Tikhonov regularization with the parameter chosen to make the data misfit and regularization terms (of the usual Tikhonov objective function) equal. Therefore, multiplicative regularization can be viewed as a purely *a posteriori* parameter choice method. For a discrete ill-posed problem, the multiplicative regularization solution exists provided the data is sufficiently close to exact data and converges to the exact solution as the data error converges to zero. The corresponding regulization parameter converges to zero like the square of the norm of the data noise, leading to under-regularization for very small noise levels. Nevertheless, the method performs well on a standard suite of test problems, as shown by comparison with another purely *a posteriori* parameter choice method, the L-curve criterion. (Received July 10, 2012)

1082-65-325 **Carlos E. Rivas Aroni**, **Paul E. Barbone*** (barbone@bu.edu) and **Assad A. Oberai**. *Improved inverse problem discretizations via augmented Lagrangian stabilization of a constrained optimization problem.*

We consider a class of partial differential equations (PDEs) that govern inverse scalar and vector potential problems. For these PDEs, we can show that following equation is satisfied: More precisely, there exists a constant $0 < C < \infty$ such that:

$$\|\delta\mu\|_\mu \leq C\|\delta u\|_u \tag{1}$$

Here, $\delta\mu$ is an infinitesimal variation in material properties, δu is the corresponding change in the relevant measured field, C is a constant. The norms in equation (1) are application dependent.

We then consider traditional FEM discretization of the PDEs, and examine the discrete counterpart to equation (1). We find in many cases that, though (1) is satisfied in the continuous case, it is not satisfied in the discrete case. We then derive improved FEM discretization methods that satisfy (1), even in the discrete case. Numerical examples shall also be presented. (Received July 10, 2012)

68 ► Computer science

1082-68-216 **Frank Löffler*** (knarf@cct.lsu.edu). *Building communities around computational challenges.*

Solving computational challenges is no longer driven by individuals, but typically by large teams, distributed around the globe. Expertise in a variety of scientific fields is necessary to develop solutions to interesting science questions. The Einstein Toolkit Consortium is such a community. It is developing and supporting open software for relativistic astrophysics. Its aim is to provide the core computational tools that can enable new science, broaden our community, facilitate interdisciplinary research and take advantage of emerging petascale computers

and advanced cyberinfrastructure. The Einstein Toolkit is supported by a distributed model, combining core support of software, tools, and documentation in its repository with partnerships with other developers who contribute open software and coordinate together on development. It currently has over 78 registered members from over 36 research groups world-wide. (Received July 09, 2012)

70 ► Mechanics of particles and systems

1082-70-100 **Kenneth R. Ball***, Box 8205, NCSU Campus, Raleigh, NC 27695, and **Dmitry Zenkov**. *Structure-preserving numerical integration and non-coordinate frames.* Preliminary report.

In mechanics it may be beneficial to make velocity substitutions that are not tied directly to the configuration coordinates. Such substitutions date back to Euler's approach to rigid body dynamics, wherein angular velocity is measured against a body frame. Hamel's formalism may be viewed as a further generalization of Euler's approach to more general mechanical systems. Variational integrators are algorithms that preserve key mechanical structures and are known to perform well in long term numerical simulations of mechanical systems. Motivated by the effectiveness of Hamel's formalism in the treatment of mechanical systems with symmetry and velocity constraints, we seek a discretization of Hamel's equations and will present some recent findings contributing to the area of structure-preserving integrators. (Received June 29, 2012)

1082-70-117 **Laurent Younes*** (laurent.younes@jhu.edu). *Metamorphosis: Morphing Discrete Measures.*

Metamorphosis provides a mathematical formulation to the well-known concept of morphing in computer graphics, in which an image (say, a face) is tranformed into another image with a combination of deformation and intensity change. This formulation induces a Riemannian metric on the space of deformable objects of interest, while allowing for changes of topology which wouldn't be possible with typical pure deformation models.

In this talk, we will discuss an extension of this concept to situations in which the compared objects are singular, focusing on the case of sums of Dirac measures. Metamorphosis can then be defined like with images, by considering measures as linear forms on a siutably selected reproducing kernel Hilbert space of functions. The morphing process then takes an interesting form, in which the Dirac singularities transform while being advected by a deformation flows, inducing new types of singularities combined non-singular components. (Received July 06, 2012)

74 ► Mechanics of deformable solids

1082-74-28 **Antonio Mastroberardino***, 4205 College Drive, Erie, PA 16563, and **Brian J. Spencer**. *Three-dimensional equilibrium crystal shapes with corner energy regularization.*

The evolution equations of crystal growth often employ a regularization of the surface energy based on a corner energy term. Here we consider the effect of this regularization on the equilibrium shape of a solid particle in three dimensions. We determine that a sufficient regularization involves only one of the two isotropic invariants related to curvature. Using a small slope approximation, we derive a nonlinear equation for the shape of a semi-infinite wedge in the case when the surface energy has cubic symmetry. An analytic description of the solution along an edge is given as well as an exact solution for a special case of anisotropy. Finally, this equation is solved numerically to demonstrate explicit solutions for which the regularization rounds the edges of the unregularized crystal shape. (Received May 14, 2012)

1082-74-127 **Gary A Richardson*** (gary.richardson@bausch.com), 1400 North Goodman Street, Rochester, NY 14609. *Reverse-Engineering of Contact Lens Mechanical Properties from an In Situ Compression Test.* Preliminary report.

Contact lenses correct the optics of the eye by placing a refractive element over the cornea. Modern lens materials are comprised of 30-90% water and exhibit viscoelasticity, hyperelasticity and thermal dependencies. These materials have traditionally proven to be extremely difficult to characterize for a number of reasons, primarily because the properties are dependent upon the processing conditions of the lenses themselves and the size and geometry of contact lenses makes them unsuitable for use in standard test apparatuses. In order to better characterize our contact lens materials we have developed an In Situ lens compression testing instrument, wherein a lens is placed in solution and compressed between two flat surfaces while applied force is recorded. FE software (Dassault Systemes Abaqus) is used to model the compression of the lens and the data matching capabilities of a process optimization software package (Dassault Systemes Isight) are used to modify the material

model parameters in order to match the test and model curves of force vs. displacement. This experimental system has allowed us to develop a much greater understanding lens material properties and provided new insights into how the behavior of the materials vary with temperature and rate of loading. (Received July 03, 2012)

1082-74-160 **Timothy J Healey***, healey@math.cornell.edu. *Nonlinear Problems for Fluid-Elastic Shells.* Preliminary report.

We consider ideal models for closed vesicles of thin lipid-bilayer membranes under pressure and/or average "concentration" loading. The main obstacle to existence theorems (and to well-posed numerical approaches) stems from the in-plane fluidity, inherent in the model. Indeed, the elasticity of the shell in bending demands a Lagragian description, whereas a full Lagrangian description of the deformation leads to uncountably many in-plane states for a given shape. We show how to overcome the difficulty here by divorcing the bending description from the measure of the local area-change. In particular, we obtain a well-posed, uniformly elliptic system, in the presence of constraints, for analysis. We establish existence theorems - the first of their kind - via techniques of symmetry-breaking global bifurcation. (Received July 05, 2012)

1082-74-177 **Antoinette M. Maniatty*** (maniaa@rpi.edu), Rensselaer Polytechnic Institute, Dept of Mech, Aero, and Nucl Engng, JEC 2049, 110 8th St, Troy, NY 12180. *Inverse Problem Solution for Interpreting X-Ray Microbeam Diffraction Measurements of Electromigration Induced Strains.*

Electromigration is a mass transport process that occurs in metal interconnects when a high electrical current density is applied. If the interconnect line is not sufficiently confined, the diffusion process may continue until a void forms at the cathode end, eventually leading to failure of the line. If the line is confined, the mass transport due to electromigration eventually leads to a build-up of a stress gradient with a diffusion driving force that is equal and opposite to that due to the high current density, and the mass transport is arrested. The push for increased performance and continued miniaturization in microelectronic devices leads to higher current densities that are more likely to cause electromigration induced failure. An inverse problem solving approach combining modeling and simulation coupled with X-ray microbeam studies, where local elastic strains are measured, can be used to resolve some of the challenging questions regarding the physics of electromigration. This talk presents a finite element based inverse problem formulation, which is used with two X-ray microbeam data sets, exhibiting opposing trends, to demonstrate how some key questions about electromigration may be answered. (Received July 06, 2012)

1082-74-302 **Michael S Richards*** (michael.richards@rocehster.edu), Department of Elect. and Comp. Engineering, Hopeman Engineering Building, Room 345, Rochester, NY 14627, and **Renato Perucchio** and **Marvin M Doyley**. *Intravascular Ultrasound Elastography: Practical and Computational Aspects of Solving the Elastic Inverse Problem.*

Understanding of arterial mechanics is essential to the detection and monitoring of unstable atherosclerotic plaque. The magnitude of stresses within plaque walls is directly related to the propensity of rupture, potentially causing a life threatening thrombus. Intravascular ultrasound elastography (IVUSe) is an imaging technique that measures vessel wall deformations during cardiac loading. Although high strain magnitudes correlate with anatomical characteristics indicative of rupture prone plaques, it is the stress magnitude and peak stress locations that dictate if and where a plaque rupture will occur. However, a mechanical model and the evaluation of the tissue mechanical properties are a necessary precursor to evaluating stresses. We have developed a minimally constrained, inverse reconstruction algorithm to quantify the shear modulus (μ) of arterial tissue imaged with IVUS. The algorithm uses a regularized solution and the inclusion of geometric segmentation information, as a penalty or soft prior, to improve the ill posedness of the inverse problem. This algorithm seeks a μ distribution, which yields a predicted deformation matching the measured field, given the model assumptions and boundary conditions. The solution is then used to image the model stresses. (Received July 10, 2012)

76 ► Fluid mechanics

1082-76-66 **Enrique Ramé***, NASA Glenn Research Center, MS 110-3, Cleveland, OH 44135. *Capillary-driven flows in corners.*

Corner channels are effective means of creating capillary-driven flows similar to those in the familiar capillary tube. These channels are widely used to position fluids in fuel tanks in spacecraft to guarantee that liquid phase –not vapor– is fed to the rocket. Steady flows develop when liquid is injected at a source location and

withdrawn at the same rate at a sink located a fixed distance downstream. Unsteady flows arise when liquid is fed by a source into an initially dry channel, with the exact dynamics being determined by the specific boundary condition at the source.

In this talk we will review the engineering challenges posed by the microgravity environment, and present a novel scaling that allows very effective theoretical predictions to be used for arbitrary corner angles and contact angles. Closed-form solutions will be shown for steady flows with and without gravity. Unsteady flows can be treated using similarity, and their dynamics derived by solving a similarity ordinary differential equation once and for all. (Received June 18, 2012)

1082-76-83 **Paul H Steen*** (phs7@cornell.edu), Chemical Engineering, Olin Hall, Cornell University, Ithaca, NY 14853, and **Anthony L Altieri**, Chemical Engineering, Olin Hall, Cornell University, Ithaca, NY 14853. *Meniscus instability in planar flow casting of molten metals.*

Planar flow melt spinning (PFMS) is a single-stage process for rapid solidifying thin metal ribbon. PFMS is used commercially to manufacture amorphous magnetic materials for use in ultra-efficient power distribution transformers, among other applications. In PFMS, liquid metal is brought into contact with a cold, rotating wheel where it is solidified into ribbon and then spun off. The 'puddle' of liquid metal is held by surface tension in a narrow planar gap between the nozzle and moving substrate. The flow is largely inviscid and the molten metal meniscus is susceptible to capillary instability. In this talk, we report a stability analysis that predicts meniscus vibrations of an inviscid fluid closely related to the Rayleigh drop oscillation. These vibrations account for a commonly observed ribbon defect. We also report progress in our effort to understand higher frequency defects of a different physical source. (Received June 26, 2012)

1082-76-106 **Chunfeng Zhou*** (zhouc1@corning.com), SP-TD-01-1, Corning, NY 14831, **Zheming Zheng** (zhengz@corning.com), SP-PR-01-3, Corning, NY 14831, and **Olus N Boratav** (boratavon@corning.com), SP-TD-01-1, Corning, NY 14831. *Draw resonance in non-isothermal non-Newtonian viscous sheets.* Preliminary report.

We study the instability known in literature as the "draw resonance" for a non-Newtonian viscous sheet of glass with non-isothermal conditions. Both eigen-solutions and transient solutions are used in the stability analysis. We will focus our discussion on the effects of viscoelasticity and thermal conditions (local or global variations) on the draw resonance stability. Our study reveals that the stability can be enhanced by both viscoelasticity and thermal heating/cooling. It also demonstrated that the critical draw ratio is increasing significantly with viscoelasticity and is sensitive to how the sheet is heated or cooled. We will also present stability results comparing sheet draw and fiber draw. (Received June 30, 2012)

1082-76-114 **Kam C Ng*** (kamchuennng@gmail.com). *Radiation impedance of whistle with branches.* Preliminary report.

A procedure to determine the radiation impedance of an open ended whistle with branches is presented. The eigenvalue problem of Helmholtz equation with boundary condition at the open end is solved. The solution is used to determine the fundamental resonance frequency by solving the same problem with Sommerfeld radiation condition at infinity. (Received July 02, 2012)

1082-76-137 **John S. Abbott*** (abbottjs@corning.com), Corning Incorporated SP-PR-1-3, Corning, NY 14831. *High speed coating of optical fibers.*

We will review the fluid mechanics of high speed coating of optical fibers [1] and give an update on the problems of air entrainment, centering forces, and the role of viscous heating.

[1] A. Friedman, Mathematics in Industrial Problems, Part 5 (The IMA Volumes in Mathematics and its Applications, Vol. 49). New York: Springer-Verlag, 1992, pp.11-20. (Received July 03, 2012)

1082-76-165 **Siavash H Sohrab*** (s-sohrab@northwestern.edu), Northwestern University, Detp. Mech. Engin., 2145 Sheridan Road, Evanston, IL 60208. *Scale Invariant forms of Cauchy, Euler, Navier-Stokes and Modified Equation of Motion and Helmholtz Vorticity Equation.*

A scale invariant model of statistical mechanics is applied to describe invariant *Cauchy*, *Euler*, *Navier-Stokes* and modified equations of motion. The invariant forms of conservation equations for mass, energy, linear, and angular momenta are expressed as

$$\mathcal{L}\rho_{i\beta} = \Omega_{i\beta}$$
$$\mathcal{L}T_{i\beta} = -T_{i\beta}\Omega_{i\beta}/\rho_{i\beta}$$
$$\mathcal{L}v_{i\beta} = -\bigtriangledown \cdot P_{ij\beta}/\rho_{i\beta} - v_{i\beta}\Omega_{i\beta}/\rho_{i\beta}$$
$$\mathcal{L}\omega_{i\beta} = \omega_{i\beta} \cdot \bigtriangledown w_{\beta} - \omega_{i\beta}\Omega_{i\beta}/\rho_{i\beta}$$

where $\mathcal{L} = \partial/\partial t + w_\beta \cdot \bigtriangledown - \nu_{i\beta}\bigtriangledown^2$ and $\nu = D = \alpha, Pr = Sc = 1$. The solutions of modified *Helmholtz* vorticity equation for problems of flow in single or multiple concentric liquid cylinders or spheres in uniform or counter flow and modified solutions of line vortex, different from *Burgers* and *Rankine* vortex, and of *Hill's* spherical vortex are presented. (Received July 05, 2012)

1082-76-273 **Kara L. Maki***, kmaki@rit.edu, and **David S. Ross** and **Molly Holz**. *The Settling Dynamics of a Contact Lens.*

When a contact lens is placed in the eye, it is fit onto the cornea by the action of the blink. The upper lid applies a normal force on the lens deforming it and squeezing the tear film out between the lens and cornea. To better understand the fit performance, we model coupled fluid and solid mechanics of the settling of a soft contact lens during a blink. (Received July 09, 2012)

1082-76-313 **David Salac*** (davidsal@buffalo.edu), University at Buffalo SUNY, 318 Jarvis Hall, Buffalo, NY 14260, and **Prerna Gera**, University at Buffalo SUNY, 318 Jarvis Hall, Buffalo, NY 14260. *Jump Conditions for the Stokes Equations with Discontinuous Viscosity and an Incompressible Interface with Singular Forces in 3D.* Preliminary report.

Here the jump conditions for pressure and velocity are presented for two-phase Stokes (and constant density Navier-Stokes) flow with discontinuous viscosity across an incompressible interface with singular forces in three dimensions. This is necessary to accurately model systems such as vesicles or red blood cells. While jump conditions for incompressible interfaces and continuous viscosity have been published, this is the first demonstration of the jump conditions for the discontinuous viscosity situation. The derivation is based on the immersed interface method and appropriate local interface conditions. In addition to presentation of the jump conditions a simple analytic case has been created to verify the method and will be shown. (Received July 10, 2012)

82 ► Statistical mechanics, structure of matter

1082-82-120 **Stephen Ng*** (ng@math.rochester.edu), **Nicholas Crawford** and **Shannon Starr**. *Emptiness formation probability in the Heisenberg antiferromagnet.* Preliminary report.

Consider the spin-1/2 Heisenberg antiferromagnet with periodic boundary conditions in d-dimensions and at fixed finite inverse temperature β. We calculate estimates of a correlation function known as the emptiness formation probability (EFP), which describes the probability that a cube of side length n contains all spins oriented up. In one-dimension, complicated but exact integral expressions are known for the EFP. In contrast, our estimates using the Aizenman-Nachtergaele graphical representation demonstrate that the EFP decays as $e^{-n^{d+1}}$ when β is sufficiently large. (Received July 02, 2012)

1082-82-132 **Stephen L Teitel*** (stte@pas.rochester.edu), Department of Physics and Astronomy, University of Rochester, Rochester, NY 14627, and **Yegang Wu**. *Maximization of Entropy and the Distribution of Stress in Jammed Granular Materials.*

In contrast to periodic crystals, densely packed "jammed" granular materials form a rigid but disordered solid with an inhomogeneous network of forces maintaining static equilibrium. Attempts to characterize the statistical distribution of such forces have a long history, beginning with the ideas of Edwards. Building upon recent work by Chakraborty and co-workers, and by Tighe and co-workers, we investigate this question by numerical simulation of a simple model of bidisperse soft-core frictionless disks in two dimensions. Creating jammed packings by a conjugate gradient energy minimization of a dense system, we measure the resulting stress tensor on sub-clusters of particles within the system. We find that the statistical distribution of such stresses is consistent with a maximum entropy hypothesis, provided one takes into account *all* the appropriate conserved quantities. (Received July 03, 2012)

1082-82-171 **Kay L Kirkpatrick*** (kkirkpat@illinois.edu), 1409 W. Green St, Department of Mathematics, UIUC, Urbana, IL 61801. *Bose-Einstein condensation, quantum many-body systems, and a central limit theorem.*

Near absolute zero, a gas of quantum particles can condense into an unusual state of matter, called Bose-Einstein condensation (BEC), that behaves like a giant quantum particle. The rigorous connection has recently been made between the physics of the microscopic many-body dynamics and the mathematics of the macroscopic model, the cubic nonlinear Schrodinger equation (NLS). I'll discuss recent progress with Gerard Ben Arous and Benjamin Schlein on a central limit theorem for the quantum many-body systems. (Received July 06, 2012)

83 ► Relativity and gravitational theory

1082-83-22 **Beverly K Berger*** (beverlyberger@me.com), 2131 Chateau Place, Livermore, CA 94550. *Using Computer Simulations of Cosmological Spacetimes to Explore the Mathematics of General Relativity.* Preliminary report.

Cosmological spacetimes with spatial symmetries provide simplified models to test theoretical, mathematical, and numerical approaches for both classical general relativity and quantum gravity. I will focus on vacuum cosmological spacetimes with 3-torus spatial topology and two Killing fields, namely, the Gowdy and "galileo" models. Roughly speaking, these models consist of gravitational waves that drive the evolution of a background spacetime that originates in a big bang and expands forever. In the collapsing direction, the focus is the nature of the approach to the big bang singularity. Numerical simulations and heuristic methods suggest that the Gowdy models are velocity dominated while the galileo models are mixmaster-like in collapse. In the former case, proofs of this behavior exist. In the latter case, there is numerical evidence that the mixmaster behavior is valid almost everywhere. These singularity studies are relevant for generic gravitational collapse. In the expanding direction, each class of model spacetime has its own interesting features. Generic Gowdy models exhibit unexpected (but now understood) behavior found by Ringström. Numerical studies of the galileo spacetimes reveal an attractor-like behavior that can be made plausible but is not yet understood. (Received May 07, 2012)

1082-83-30 **Matthew Anderson*** (andersmw@indiana.edu), Wrubel Computing Center, 2711 East Tenth Street, Bloomington, IN 47408. *Neutron Star Evolutions using Tabulated Equations of State with a New Execution Model.*

Future achievements in computational science demand innovations in parallel computing models and methods to improve efficiency and dramatically increase scalability. One controversial issue is the relative value of global address space models and management versus more conventional distributed memory structure. This talk demonstrates one important use of global address space in the context of the advanced ParalleX execution model that has enabled improvements in neutron star simulations with a finite temperature equation of state.

The addition of nuclear and neutrino physics to general relativistic fluid codes allows for a more realistic description of hot nuclear matter in neutron star and black hole systems. This additional microphysics requires that each processor have access to large tables of data; the memory required for these tables can become excessive unless an alternative execution model is used. We present relativistic fluid evolutions of a neutron star obtained using a message driven multi-threaded execution model known as ParalleX and compare performance results with the conventional approach. We also discuss asynchrony management in the context of particle-in-cell, Barnes-Hut, and adaptive mesh refinement algorithms. (Received May 15, 2012)

1082-83-36 **Geoffrey Lovelace*** (geoffrey4444@gmail.com), Gravitational-Wave Physics & Astronomy Center, Dept. of Physics, Cal. State Univ. Fullerton, 800 North State College Blvd., Fullerton, CA 92834. *Simulating compact-binary mergers containing nearly extremal black holes.*

When compact objects (black holes, neutron stars, or white dwarfs) spiral together and merge, they emit gravitational waves which are among the most promising sources for detectors such as the Advanced Laser Interferometer Gravitational-Wave Observatory (Advanced LIGO, scheduled for completion in 2015). There is a significant possibility that nearly extremal black holes (i.e., holes spinning nearly as rapidly as possible) exist and thus are among the compact-binary mergers that Advanced LIGO could detect. Numerical-relativity simulations of compact-binary mergers—necessary for predicting the emitted gravitational waveforms and for exploring the highly nonlinear, strongly warped spacetime near the holes' horizons—are particularly challenging when they contain nearly extremal black holes. In this talk, after discussing some of these challenges and current methods to address them, I will present results from recent simulations of black hole-black hole and black hole-neutron star mergers where the holes are nearly extremal. (Received May 18, 2012)

1082-83-61 **Robert Owen*** (rowen@oberlin.edu). *Physical Interpretation of Numerical Spacetimes.*

Numerical relativity provides a marvelous testbed for exploring the nonlinear dynamics of spacetime. When considering problems involving multiple black holes, it is tempting to interpret interactions in the language of Newtonian physics. Unfortunately, such efforts are clouded by two (related) peculiarities of general relativity: the nonlocal nature of energy and momentum, and the nonexistence of a preferred family of coordinate systems. The former issue can be partially ameliorated with the help of quasilocal constructions. The latter issue is more open. In this talk, I will review some of the tools used in modern numerical relativity, particularly in the SpEC code, for interpreting the dynamics of generic spacetimes. (Received June 18, 2012)

1082-83-161 **Jennie D'Ambroise*** (jdambroise@gmail.com), PO Box 5000, Annandale-on-Hudson, NY 12504, and **Floyd L Williams**. *Parametric and other exact solutions to Einstein's equations in terms of special functions.*

In this talk I will review recent results regarding solutions of Einstein's equations using elliptic functions. In certain cosmological models with a perfect fluid energy-momentum tensor, the Einstein equations of general relativity reduce to a differential equation whose solutions can be found in terms of Jacobi or Weierstrass elliptic functions. Moreover, in recent joint work with Floyd L. Williams we find more widespread applications of special functions for cosmological models including Bianchi V, Bianchi IX, and Szekeres-Szafron. In these models solutions are found by specifying the parameters in a general nonlinear differential equation, which we solve parametrically in terms of the Weierstrass elliptic, sigma and zeta functions. (Received July 05, 2012)

1082-83-174 **James A. Isenberg*** (isenberg@uoregon.edu). *The Conformal Method and Solutions of the Einstein Constraint Equations: A Status Report.*

The Conformal Method (as well as the closely related Conformal Thin Sandwich Method) has proven to be a very useful procedure both for constructing and for parametrizing solutions of the Einstein initial data constraint equations, for initial data sets with constant mean curvature (CMC). Is this true for non CMC data sets as well? After reviewing the CMC results, we discuss what we know and don't know about non CMC initial data sets and the effectiveness of the Conformal Method in handling them. (Received July 06, 2012)

1082-83-214 **Harald P Pfeiffer*** (pfeiffer@cita.utoronto.ca), CITA, University of Toronto, 60 St. George Street, Toronto, Ontario M5S 3H8, Canada. *Simulations of black hole binaries: Techniques and results for precessing binaries.*

Numerical studies of binary black holes are motivated by the desire to solve the general relativistic two body problem, and because of their importance for gravitational wave detectors like LIGO. Generically, black hole binaries will carry spins which cause the orbital plane and each spin-vector to precess. This talk presents techniques to efficiently simulate precessing binaries and discusses results of simulations of precessing binaries. (Received July 08, 2012)

1082-83-257 **Marcelo Ponce*** (mjponce@uoguelph.ca), Department of Physics, University of Guelph, 50 Stone Road East, Guelph, Ontario N1G 2W1, and **Mathew Anderson**, **Luis Lehner**, **Steven L. Liebling** and **Carlos Palenzuela**. *Neutron Star Magnetospheres interactions in force-free plasma.* Preliminary report.

The study of the magnetic fields in neutron stars (i.e., magnetospheres) may have important impact on the detection of electromagnetic signals from these objects, especially in dynamical situations. In this talk I will discuss the interaction of neutron star magnetospheres with an external magnetic field like the one produced by another star. I will also consider the case where the star is collapsing to a black hole. In order to numerically simulate such systems, it is necessary to implement the fully nonlinear field equations of General Relativity coupled to Maxwell equations. I will describe a novel approach that our code uses to match different limits of the Maxwell equations, namely the force-free approximation to describe the magnetospheres and the ideal magneto-hydrodynamics (MHD) that is well suited for the bulk of the star. (Received July 09, 2012)

1082-83-286 **Joshua Faber*** (jafsma@rit.edu), School of Mathematical Sciences, Center for Comput. Relativity and Gravitation, Rochester Institute of Technology, Rochester, NY 14623. *Numerical Techniques for Generating Initial Data in General Relativity.*

Generating initial data for numerical evolutions in general relativity typically requires the solution of several linked non-linear elliptic equations. Here, we discuss various domain decompositions and coordinate transformations that can be used to generate initial data representing neutron stars and black holes in binaries and more general configurations. Particular attention is paid to spectral approaches, and the ways they may be used to generate extremely accurate solutions to the constraint equations. (Received July 10, 2012)

1082-83-287 **Carlos Oscar Lousto*** (colsma@rit.edu), NY, and **Manuela Campanelli**, **Yosef Zlochower**, **Marta Volonteri** and **Massimo Dotti**. *Gravitational Recoil From Merging Black-Hole Binaries.*

We explore the newly discovered 'hangup-kick' effect, which amplifies the recoil for configuration with partial spin- orbital-angular momentum alignment, by studying a set of 48 new simulations of equal-mass, spinning black-hole binaries. We propose a phenomenological model for the recoil that takes this effect into account and then use this model, in conjunction with statistical distributions for the spin magnitude and orientations, based on accretion simulations, to find the probabilities for observing recoils of several thousand km/s. Our results indicate that surveys exploring peculiar differential line-of-sight velocities should observe at least one case above

2000 km/s out of four thousand merged galaxies. The probability that a remnant BH receives a total recoil exceeding the 2000 km/s escape velocity of large elliptical galaxies is ten times larger. Probabilities of recoils exceeding the escape velocity quickly rise to 5% for galaxies with escape velocities of 1000 km/s and nearly 20% for galaxies with escape velocities of 500 km/s. In addition the direction of these large recoils is strongly peaked toward the angular momentum axis, with very low probabilities of recoils exceeding 350 km/s for angles larger than 45 deg. with respect to the orbital angular momentum axis. (Received July 10, 2012)

1082-83-312 **Erik Schnetter*** (eschnetter@perimeterinstitute.ca), Perimeter Institute for Theoretical Physics, 31 Caroline St. N., Waterloo, ON N2L 2Y5, Canada. *Modern methods in numerical relativity.*

General relativity plays a central role in many astrophysical or cosmological applications, when either densities are high or where the global structure of spacetime is relevant. As applications become more complex, numerical methods become indispensible to study such systems and to make concrete, testable predictions. These days, standard numerical calculations include general relativity, relativistic magneto-hydrodynamics, realistic equations of state, and radiative transfer, and are used to study system such as black holes, neutron stars, binaries of these, or core-collapse supernovae.

As many effects are fundamentally multi-dimensional and time-dependent, numerical methods and algorithms need to be parallel, distributed, and scalable, so that modern computational resources can be applied.

I will present the modelling of core-collapse supernovae as particular astrophysics problem, and use this example to describe a wide range of numerical methods and computational algorithms we employ to study these systems. I will also briefly describe the Einstein Toolkit, a community project where we make open-source implementations of these available to the public. (Received July 10, 2012)

85 ► Astronomy and astrophysics

1082-85-253 **Carlos Palenzuela***, palen@cita.utoronto.ca. *Hyperbolic-relaxation systems in Astrophysics: going beyond ideal MHD.*

Hyperbolic systems with relaxation terms appears naturally in many astrophysical scenarios involving matter fields. Depending on the nature of the stiff terms, these systems can be solved in a straightforward way by using the Implicit-Explicit (IMEX) Runge-Kutta time integrators. In this talk I will describe the General-Relativistic Resistive Magnetohydrodynamics (GR-RMHD) equations, a very common hyperbolic-relaxation system in astrophysics, and how to exploit the properties of the IMEX Runge-Kutta methods to deal with the stiffness of the electric current. The implementation is verified by using tests in 1D, 2D and 3D, showing that the method is robust and recovers the ideal-MHD limit in regimes of very high conductivity. Moreover, the results illustrate that the code is capable of describing physical setups in all ranges of conductivities. (Received July 09, 2012)

90 ► Operations research, mathematical programming

1082-90-14 **Vikram Jeet Singh*** (vikram31782@gmail.com), H.NO 908/7 STREET NO.4, KOT ATMA SINGH RAM BAGH AMRITSAR, Amritsar, Punjab 143001, India. *Modeling and Analysis of an Inventory System with Ramp Type Demand rate and Backlogging.*

In this paper an inventory model for deteriorating and ameliorating items with variable holding cost has been developed. we considered the ameliorating items which follow time varying demand with ramp type pattern. Shortages are permitted and partially back-ordered. The back-ordering fraction is taken to be decreasing function of waiting time. Total cost of the system is formulated and optimal replenishment policy is derived, keeping in view the above factors of the system. (Received March 09, 2012)

1082-90-304 **Ke Han*** (kxh323@psu.edu), 402 McAllister Building, State College, PA 16802. *Existence and Computation of Dynamic User Equilibrium.*

Dynamic Traffic Assignment (DTA) is usually viewed as the descriptive modelling of time-varying flows on vehicular networks consistent with established traffic flow. This paper is concerned with a specific type of DTA known as Dynamic User Equilibrium for which unit travel cost, including early and late arrival penalties, is identical for those route and departure time choices selected by travellers between a given origin-destination pair. We will first discuss the existence of the continuous-time DUE, which is formulated as an infinite-dimensional variational inequality. The DUE is then re-formulated as a differential variational inequality and computed

with a fixed-point iteration scheme in continuous time. Finally, we will present numerical results for DUE on a vehicular network of reasonable size. (Received July 10, 2012)

91 ► Game theory, economics, social and behavioral sciences

1082-91-178 **Maxim Bichuch** (mbichuch@princeton.edu), 118 Sherrerd Hall, Princeton University, Princeton, NJ 08544, and **Stephan Sturm*** (ssturm@wpi.edu), Stratton Hall 202C, Worcester Polytechnic Institute, 100 Institute Road, Worcester, MA 01609. *Optimal Incentives for Delegated Portfolio Optimization.* Preliminary report.

We study the problem of an investor who lets a fund manager manage his wealth. The latter is paid by an incentive scheme based on the performance of the fund. Manager and investor have different risk aversions; the manager may invest in a financial market to form a portfolio optimal for his expected utility whereas the investor is free to choose the incentives – taking only into account that the manager is paid enough to accept the managing contract. (Received July 06, 2012)

92 ► Biology and other natural sciences

1082-92-2 **James P Keener*** (keener@math.utah.edu), 155 South 1400 East, Salt Lake City, UT 84108-1231. *The Mathematics of Life - Decisions, Decisions.*

In order to survive, living organisms must constantly make decisions, about what to eat, when and where to move, when to reproduce, when to build, when to destroy, etc.

In this talk I will give an overview of the mathematics of decision making, namely the mathematical principles that underlie biological processes of measurements, switches, and signals. The short answer to how decisions are made is that the rate of molecular diffusion contains information that can be transduced by biochemical reactions to give control over behavior. These processes can be given quantitative descriptions using diffusion-reaction equations, and the study of these equations gives valuable insights into how organisms work as well as an opportunity to learn and develop new mathematics. I will illustrate this dual role of quantitative reasoning by way of several specific examples from cell biology. (Received July 08, 2012)

1082-92-150 **Kathleen Ann Lamkin-Kennard*** (kaleme@rit.edu), 76 Lomb Memorial Drive, GLE-2185, Rochester, NY 14623. *Applied Mathematics as a Predictive Tool for Improving the Understanding of Microcirculatory Phenomena.*

The microcirculation of the human body is responsible for regulation and control of many physiological processes, including physiological signaling, the inflammatory response, and regulation of vascular tone. Although many important processes occur in the microcirculation, the average diameters of the vessels in the microcirculation range from 5 to 200 microns, making it difficult to experimentally measure and observe factors of interest in these vessels. Mathematical modeling is becoming increasingly used as a tool for furthering the understanding of processes in the microcirculation. Two examples of microcirculatory processes that can be modeled mathematically include simulation of coupled nitric oxide and oxygen transport using nonlinear partial differential equations and simulation of white blood cell margination and rolling using boundary element techniques. The use of mathematical modeling has allowed important information about the role that fluctuations in nitric oxide play in the development of various disease states, such as glaucoma, to be predicted as well as the effects of network geometries on white blood cell transport to be further quantified. (Received July 05, 2012)

1082-92-151 **Thomas Quail*** (td.quail@gmail.com), Department of Physiology, McGill University, Rm. 1125 3655 Promenade Sir William Osler, Montreal, Quebec H3G 1Y6, Canada. *Complex cardiac dynamics and transitions around an anatomical obstacle.*

Wave reentry around an anatomical obstacle in the heart can precipitate sudden cardiac arrest. Obstacles of varying diameter (from between 1 mm to 8 mm) were introduced in the context of a 1-cm-diameter cardiac monolayer composed of spontaneously-beating, spatially-coupled ventricular cells from 8-day-old embryonic chicks. Complex dynamics were observed following the introduction of the obstacle: reentry, pacemaker-spiral dynamics, spiral-spiral dynamics. A simplified, two-dimensional Fitzugh-Nagumo mathematical model was developed to describe the possible dynamics for differently-sized annuli. The transition from one-dimensional dynamics—circulating reentrant waves around a ring—to two-dimensional dynamics—counter-rotating spiral waves, for example—was described as a function of the obstacle's radius. (Received July 05, 2012)

1082-92-154 **Jiehua Zhu*** (jzhu@georgiasouthern.edu), Mathematical Sciences, Georgia Southern University, Statesboro, GA 30460, and **Xiezhang Li** (xli@georgiasouthern.edu), Mathematical Sciences, Georgia Southern University, Statesboro, GA 30460. *A generalized l_1 greedy algorithm for image reconstruction in computerized tomography.* Preliminary report.

The sparse vector solutions for an underdetermined system of linear equations Ax = b have many applications in signal recovery and image reconstruction in tomography. Under certain conditions, the sparsest solution can be found by solving a constrained l_1 minimization problem: min $||x||_1$ subject to Ax = b. A generalized l_1 greedy algorithm for computerized tomography is proposed in this work. Numerical experiments are also given to illustrate the advantages of the new algorithm. (Received July 05, 2012)

1082-92-175 **Trine Krogh-Madsen*** (trk2002@med.cornell.edu), New York, NY 10021, and **Geoffrey W. Abbott** and **David J. Christini**. *Multi-scale modeling of atrial fibrillation maintenance and dynamics.*

Atrial fibrillation, a common cardiac arrhythmia, often progresses unfavourably: in patients with long-term atrial fibrillation, fibrillatory episodes are typically of increased duration and frequency of occurrence relative to healthy controls. This is due to different remodeling processes, which include changes to the electrophysiology of individual cells and to intercellular coupling. We investigated mechanisms by which remodeling effects simulated atrial fibrillation, using a mathematical model of the human atrial action potential incorporated into an anatomically realistic three-dimensional structural model of the human atria. We found that the average duration of simulated atrial fibrillation episodes increases with remodeling induced wavelength shortening, regardless of whether the reduced wavelength is caused primarily by a shortening of the action potential duration or by a decrease in conduction velocity. However, arrhythmia dynamics varied substantially with different types and levels of remodeling, including differences in maximal number of filaments, wave fragmentation, restitution properties, and wave anchoring. These findings have implications for our understanding of the mechanisms by which long-term atrial fibrillation remodeling processes perpetuate the disease. (Received July 06, 2012)

1082-92-185 **Christian W Zemlin*** (czemlin@odu.edu), Bioelectrics Institute, 4211 Monarch Way, Rm 370, Norfolk, VA 23508, **Marcel Wellner** (wellnerm@upstate.edu), Department of Pharmacology, 750 E Adams Street, Syracuse, NY 13210, and **Arkady M Pertsov** (pertsova@upstate.edu), Department of Pharmacology, 750 E Adams Street, Syracuse, NY 13210. *Snell's law and the geodesic principle for scroll wave filaments.*

It has been shown that stationary scroll wave filaments in excitable media describe a geodesic in a curved space whose metric is the inverse diffusion tensor (geodesic principle) as long as the diffusion tensor has constant determinant. Here we show that if there is an abrupt change in the determinant, the filament at the interface obeys Snell's law, with the two determinants taking the role of refractive indices. We also show that Snell's law is what the geodesic principle predicts, which means that the geodesic principle applies more generally than previously known. Following the analogy between filament shape and optical diffraction, we construct a filament that corresponds to the optical phenomenon of total reflection and find that it leads to interesting filament dynamics. (Received July 06, 2012)

1082-92-249 **Jingjia Xu*** (jxx2144@rit.edu), 102 Lomb Memorial Drive, Rochester, NY 14623, and **Azar Rahimi** and **Linwei Wang** (lxwast@rit.edu), 102 Lomb Memorial Drive, Rochester, NY 14623. *Localization of Sparse Excitation Stimuli from Surface Mapping in Cardiac Electrophysiological System.*

As *in-silico* 3D electrophysiological (EP) models start to play an essential role in revealing transmural EP characteristics and diseased substrates in individual hearts, there arises a critical challenge to initialize EP models. We proposed a novel method to localize transmural stimuli based on spatial sparsity using surface data. To overcome the mathematical ill-posedness caused by the limited measurement data, a neighborhood-smoothness constraint is used to first obtain a "blur" estimation of sparse solution. This is then used to initialize an iterative, re-weighted regularization to enforce a sparse solution to overcome the physical ill-posedness from electromagnetic field. Phantom experiments are performed on a human model to evaluate accuracy in localizing excitation stimuli at different regions within the ventricles, as well as to test its feasibility in differentiating multiple stimuli. Real-data experiments are performed on two porcine hearts, where activation isochronous simulated with the reconstructed stimuli are significantly closer to the catheterized mapping data than other stimuli configurations. This method has the potential to benefit the current research in subject-specific EP modeling as well as to facilitate clinical decisions of ectopic foci. (Received July 11, 2012)

1082-92-251 **Jue Wang*** (wangj@union.edu) and **Yongjian Yu**. *Segmentation and Artifact Correction in Ultrasound Images.*

Ultrasound B-scan exhibits shadowing and enhancement artifacts due to acoustic wave propagation and spatially varying attenuation across tissue layers. Estimation of local attenuation coefficients is important for clinical diagnosis and analysis. We will present the mathematical framework of a novel joint estimation method for attenuation compensation and artifact reduction in ultrasound, together with boundary segmentation. Spatial resolution and speckle patterns are retained. Our results give higher quality attenuation compensation compared to several existing techniques using B-mode or RF images. (Received July 09, 2012)

1082-92-254 **Abhishek Murthy*** (amurthy@cs.sunysb.edu), **Ezio Bartocci**, **Flavio H. Fenton**, **James Glimm**, **Richard A. Gray**, **Elizabeth M. Cherry**, **Scott A. Smolka** and **Radu Grosu**. *Curvature Analysis of Cardiac Excitation Wavefronts.*

We present the *Spiral Classification Algorithm* (SCA), a fast and accurate algorithm for classifying electrical spiral waves and their associated breakup in cardiac tissues. The classification performed by SCA is an essential component of the detection and analysis of various cardiac arrhythmic disorders, including ventricular tachycardia and fibrillation. Given a digitized frame of a propagating wave, SCA constructs a highly accurate representation of the front and the back of the wave, piecewise interpolates this representation with cubic splines, and subjects the result to an accurate curvature analysis. To increase the smoothness of the resulting symbolic representation, the SCA uses weighted overlapping of adjacent segments which increases the smoothness at join points.

SCA has been applied to a number of representative types of spiral waves, and, for each type, a distinct curvature evolution in time (signature) has been identified. Distinct signatures have also been identified for spiral breakup. These results represent a significant first step in automatically determining parameter ranges for which a computational cardiac-cell network accurately reproduces a particular kind of cardiac arrhythmia, such as ventricular fibrillation. (Received July 09, 2012)

1082-92-261 **Elizabeth M Cherry*** (elizabeth.cherry@rit.edu). *Contribution of the Purkinje network to wave propagation in the canine ventricle: Insights from a combined electrophysiological-anatomical model.*

The heart includes a specialized conduction system that ensures the necessary activation sequence and timing of the ventricles to produce an effective contraction. The role of this system, called the Purkinje network, during ventricular tachyarrhythmias remains unclear. To study how the Purkinje network interacts with ventricular muscle, we developed a combined electrophysiology-structural model of the canine Purkinje network based on microelectrode recordings and a digitized reconstruction of the Purkinje system. Using our combined model, we found that two different results could occur: the long-range connections provided by the Purkinje network could depolarize the tissue more quickly, thereby promoting arrhythmia termination, but if termination did not occur, the Purkinje system could increase the dispersion of refractoriness in the tissue, thereby sustaining the arrhythmia. The different behaviors result from the two competing effects contributed by the Purkinje network: effective reduction in tissue size and increased spatial heterogeneity. (Received July 09, 2012)

1082-92-262 **Flavio H Fenton*** (flavio.h.fenton@cornell.edu). *Interactive simulations of complex systems and spiral wave dynamics: Exploiting graphics processing units on a laptop or PC for real-time computations over the Internet.*

A graphics processing unit (GPU) is a specialized electronic circuit designed to rapidly access and manipulate memory to accelerate the generation of images for fast output to a display. However, over the past decade, the GPU's massively parallel architecture structure has enabled it to accelerate general purpose scientific and engineering computing. WebGL is a new web-based cross-platform technology that allows the execution of JavaScript and Shader codes directly to a computer's GPU from a web browser without the need for any plug-ins. Therefore, it is now possible to run high-performance parallel computing simulations over the web on a local PC or laptop independent of the operating system used. In this talk I will show how the complicated spatiotemporal dynamics of reaction-diffusion equations (which are typical of biological systems including the electrical dynamics of the heart) can be simulated in large domains and studied in real time using GPUs. I also will describe how we developed an interactive educational module incorporating GPU-based simulations that teaches cardiac dynamics and the development of arrhythmias and has been used successfully at various levels ranging from middle school to undergraduate and graduate students. (Received July 09, 2012)

1082-92-310 **Benjamin R. Liu*** (brl5686@rit.edu). *Curve fitting to sparse experimental data: Implications for the dynamics of cardiac electrophysiology models.*

Mathematical models and computer simulation have become widely used in the field of cardiac electrophysiology; however, experimental data used in the construction of these models is often sparse or incomplete, leading to mathematically problematic assumptions. Here we investigate the sensitivity of the Ten Tusscher-Panfilov (TP) human ventricular cell model to function definitions chosen by modelers, and present results illustrating the sensitivity of the TP model dynamics in both single-cell and tissue simulations. (Received July 10, 2012)

94 ► Information and communication, circuits

1082-94-234 **Lixin Shen*** (lshen03@syr.edu), Syracuse, NY 13244, and **Bruce W Suter**, Rome, NY 13441. *Compressive Sampling at the Information Directorate of the Air Force Research Laboratory: Theoretical Basis for New Algorithms.* Preliminary report.

We will begin by presenting a brief tutorial on compressive sampling and its relevance to the Air Force. Subsequently, we will present new research results in compressive sampling that highlight improvements possible for the increase of accuracy and the decrease of computation time. The talk will conclude with an application of this compressive sampling research to distributed spectrum sensing and analysis. (Received July 09, 2012)

1082-94-239 **Bruce W. Suter*** (bruce.suter@rl.af.mil), AFRL/RITB, 525 Brooks Road, Rome, NY 13492. *Session Title: Compressive Sampling at the Information Directorate of the Air Force Research Laboratory Bruce Suter – Overview of Compressive Sampling.* Preliminary report.

We will begin by presenting a brief tutorial on compressive sampling and its relevance to the Air Force. Subsequently, we will present new research results in compressive sampling that highlight improvements possible for the increase of accuracy and the decrease of computation time. The talk will conclude with an application of this compressive sampling research to distributed spectrum sensing and analysis. (Received July 09, 2012)

1082-94-243 **Megan Lewis*** (c13megan.lewis@usafa.edu). *Session Title: Compressive Sampling at the Information Directorate of the Air Force Research Laboratory Megan Lewis – Computational Basis for New Algorithms.* Preliminary report.

We will begin by presenting a brief tutorial on compressive sampling and its relevance to the Air Force. Subsequently, we will present new research results in compressive sampling that highlight improvements possible for the increase of accuracy and the decrease of computation time. The talk will conclude with an application of this compressive sampling research to distributed spectrum sensing and analysis. (Received July 09, 2012)

1082-94-245 **Ashley A. Prater*** (ashleyannprater@gmail.com). *Session Title: Compressive Sampling at the Information Directorate of the Air Force Research Laboratory Ashley Prater – Distributed Spectrum Sensing and Analysis.* Preliminary report.

We will begin by presenting a brief tutorial on compressive sampling and its relevance to the Air Force. Subsequently, we will present new research results in compressive sampling that highlight improvements possible for the increase of accuracy and the decrease of computation time. The talk will conclude with an application of this compressive sampling research to distributed spectrum sensing and analysis. (Received July 09, 2012)

1082-94-330 **Yang Wang*** (ywang@math.msu.edu), Department of mathematics, Michigan State University, East Lansing, MI 48824. *A sub-linear time algorithm for sparse Fourier representations.*

We present a new algorithm for the sparse Fourier transform problem, in which we seek to identify $k \ll N$ significant Fourier coefficients from a signal of bandwidth N. Previous deterministic algorithms exhibit quadratic runtime scaling, while our algorithm scales linearly with k in the average case. Underlying our algorithm are a few simple observations relating the Fourier coefficients of time-shifted samples to unshifted samples of the input function. This allows us to detect when aliasing between two or more frequencies has occurred, as well as to determine the value of unaliased frequencies. We show that empirically our algorithm is orders of magnitude faster than competing algorithms. (Received July 11, 2012)

97 ► Mathematics education

1082-97-10 **Dr. Maha Nabhan**, **Mr. Mahmoud Syam** and **Mrs.Maysoon Sewailem*** (maysoon.swalem@qu.edu.qa), Doha, Po Box 271, Qatar. *Exploring Factors that Have Negative Effects on the Teaching of Mathematics at Qatar University Foundation Program -A case study –.*

There are some factors that have negative effects on the teaching of mathematics. Some of these factors come from the class setting itself (in terms of class equipment's, class size, class time and location) and others come from students behaviors during class time (in terms of being late or absent to class or in terms of using their mobile phones or talking to class mates during the lecture). Also, the factors may involve the academic level of the student or their ability to understand Mathematics in a language different from their mother tongue.

In this paper, we will ask, through a questionnaire, the Math lecturers and teaching assistants in Foundation Program about the problems they face during class time. The questionnaire will consist of 24 questions and be distributed to them via the "Survey Monkey". The questionnaire will help us to determine the main problems facing the teachers in the classroom. An analysis of the results and some figures will be presented, some hypotheses will also be tested, and conclusions and recommendations will be drawn. (Received January 20, 2012)

1082-97-24 **Leslie Chandrakantha*** (lchandra@jjay.cuny.edu), Mathematics Department, 524 West 59th Street, New York, NY 10019. *Simulating the Chi-square Test for Independence.*

Hypothesis testing is one of the difficult concepts for students to understand in an introductory statistics course. This paper describes how to use the simulation in Excel to perform the chi-square test for independence between two categorical variables in a two-way table. The Excel Data Table function and standard Excel functions are used to calculate the values of the test statistic for different random samples and the corresponding p-value. The random samples of observations for the two-way table are generated using independent binomial distributions. The empirical distribution of the test statistic is also tabulated and it agrees closely with the theoretical distribution. This approach will improve the students' ability to understand the meaning of the p-value and to interpret the results of hypothesis testing. (Received May 09, 2012)

05 ► Combinatorics

1083-05-25 **Steven Andrew Schluchter*** (sas71@gwu.edu), 2115 G St. NW, 240, Washington, DC 22201. *Voltage Graphs and Derived Cellular Homology (preliminary report).* Preliminary report.

Voltage graph theory has been used to answer questions about regular (branched) coverings of graphs and surfaces. It has also been used as a tool to answer questions in topological graph theory and in the classification of cellular automorphisms of surfaces. Here, we will discuss the initial results of an investigation into homology classes of closed walks in covering spaces over closed walks in the covered spaces using voltage-graph theory. (Received July 18, 2012)

1083-05-29 **Fabrizio Zanello*** (zanello@math.mit.edu), Department of Mathematical Sciences, Michigan Tech, Houghton, MI 49931-1295. *Some old and new (non)unimodality results.*

Asking whether a given sequence is unimodal is often a central question in combinatorics and combinatorial commutative algebra. Just recently, this question has been the object of a considerable amount of research, which has seen the most exciting breakthrough in the work of Huh and Huh-Katz on the unimodality of the face vectors of representable matroids. I will review a number of results and open problems on unimodal sequences, from Stanley's original proof of the nonunimodality of Gorenstein Hilbert functions, to my 2006 result on level algebras, to the recent progress contained in the pure O-sequences memoir. In the last portion of the talk, I will outline a proof that even the face vectors of Cohen-Macaulay simplicial complexes can be nonunimodal with arbitrarily many peaks, a fact that improves several previous results in this area. (Received July 23, 2012)

1083-05-40 **Patrik Norén*** (patrik.noren@aalto.fi), Aalto University, Department of Mathematics, P.O. Box 11100, FI-00076 Helsinki, Finland, and **Alexander Engström** (alexander.engstrom@aalto.fi), Aalto University, Department of Mathematics, P.O. Box 11100, FI-00076 Helsinki, Finland. *Cellular resolutions of powers of edge ideals.* Preliminary report.

We study powers of edge ideals of graphs and their resolutions. For a large class of graphs, we construct new cellular resolutions for each power of the corresponding edge ideals. In many cases it is possible to use algebraic discrete Morse theory to make the cellular resolutions minimal. In particular, we give an explicit description of the minimal resolutions for all powers of edge ideals of paths. (Received August 06, 2012)

1083-05-44 **Jeremy L Martin*** (jmartin@math.ku.edu) and **Jennifer D Wagner** (jennifer.wagner1@washburn.edu). *On the Spectra of Simplicial Rook Graphs.*

The *simplicial rook graph* $SR(d,n)$ is the graph whose vertices are the lattice points in the nth dilate of the standard simplex in $\mathbb{R}^d$, with two vertices adjacent if they differ in exactly two coordinates. We prove that $SR(3,n)$ has integral spectrum for every n, by calculating an explicit eigenbasis. In addition, we present evidence in support of the conjecture that $SR(d,n)$ is integral for all d and n. (Received August 07, 2012)

1083-05-58 **Nicholas A. Loehr**, **Jeffrey B. Remmel** and **Bruce E. Sagan*** (sagan@math.msu.edu). *A factorization theorem for m-rook placements.* Preliminary report.

Let $B = (b_1, b_2, \ldots, b_n)$ be an integer partition where the parts are listed in weakly increasing order. We also consider B as a Ferrers board where b_j is the height of column j and the columns are bottom justified. Letting $r_k(B)$ denote the number of placements of k rooks on any board B and $x\downarrow_k = (x)(x-1)\cdots(x-k+1)$, we have the famous Factorization Theorem of Goldman-Joichi-White which states that for any Ferrers board as above we have $\sum_{k\geq 0} r_k(B) x\downarrow_{n-k} = \prod_j (x + b_j - j + 1)$. Briggs and Remmel considered a generalization of rook placements to m-rook placements which are related to wreath products $C_m \wr S_N$ where C_m is a cyclic group and S_N a symmetric group. Ordinary rook placements correspond to the case $m = 1$. They were able to prove a version of the Factorization Theorem in this setting, but only for certain Ferrers boards. We give a generalization which holds for all Ferrers boards. (Received August 14, 2012)

1083-05-61 **Naichung Conan Leung*** (leung@math.cuhk.edu.hk). *Counting lattic points in Gorenstein cones.*

We obtain a lower estimate of the growth of the number of lattice points inside Gorenstein cones. Our tools include toric geometry, orbifold Riemann-Roch formula, Einstein metrics and Yau's Chern number inequality. This is a joint work with Zhiming Ma. (Received August 15, 2012)

1083-05-63 **Tom Halverson*** (halverson@macalester.edu), Macalester College, Saint Paul, MN 55104. *Rook Schur-Weyl Duality.* Preliminary report.

We introduce two centralizer algebras: the rook-Brauer algebra $\mathsf{RB}_k(x)$ and the Motzkin algebra $\mathsf{M}_k(x)$ (which can be viewed as the rook-Temperley-Lieb algebra). These are constructed from the Brauer and Temperley-Lieb algebras in the same way that the rook monoid algebra is constructed from the symmetric group algebra: by allowing the omission of edges from basis diagrams. For certain choices of the parameter x, these algebras are in Schur-Weyl duality with the orthogonal group $\mathsf{O}_n(\mathbb{C})$ and the general linear group $\mathsf{GL}_2(\mathbb{C})$, respectively, on tensor space, just as the rook monoid is in Schur-Weyl duality with $\mathsf{GL}_n(\mathbb{C})$ on tensor space (Solomon, 2002). Beyond looking at the algebraic combinatorics of these two diagram algebras, we examine generalities of rook Schur-Weyl duality. (Received August 15, 2012)

1083-05-81 **Brian K. Miceli*** (bmiceli@trinity.edu), Mathematics Department, One Trinity Place, San Antonio, TX 78213. *A rook model for poly-Stirling numbers.*

Let $p(x)$ denote a polynomial and consider the recursion

$$S(n+1,k,p(x)) = S(n,k-1,p(x)) + p(k)S(n,k,p(x)),$$

where $S(0,0,p(x)) = 1$ and $S(n,k,p(x)) = 0$ if $n < k$ or $k < 0$. We call such numbers *poly-Stirling numbers of the second kind*. In the case where $p(x) = x$, this recursive formula defines the well-known classical Stirling numbers of the second kind, and in the case where $p(x) = x^2$ this recursive formula defines the triangle central factorial numbers. In this talk we define a rook theory model which gives a combinatorial interpretation of poly-Stirling numbers for general $p(x)$ with nonnegative, integer coefficients. We also define two q-analogues of this formula and give corresponding rook theoretic interpretations. (Received August 19, 2012)

1083-05-95 **Benjamin J Braun*** (benjamin.braun@uky.edu), 715 Patterson Office Tower, Department of Mathematics, University of Kentucky, Lexington, KY 40506, and **Matthias Beck**, San Francisco State University. *Euler-Mahonian Statistics via Polyhedral Geometry.*

A variety of descent and major-index statistics have been defined for symmetric groups, hyperoctahedral groups, and their generalizations. Typically associated to pairs of such statistics is an Euler-Mahonian distribution, a bivariate generating function identity encoding these statistics. We use techniques from polyhedral geometry to establish new multivariate generalizations for many of the known Euler-Mahonian distributions. The original bivariate distributions are then straightforward specializations of these multivariate identities. A consequence of these new techniques are bijective proofs of the equivalence of the bivariate distributions for various pairs of statistics. This is joint work with Matthias Beck. (Received August 22, 2012)

1083-05-96 **Lex E. Renner*** (lex@uwo.ca), Department of Mathematics, Middlesex College, Western University, London, Ontario N6A 5B7, Canada. *Generalized Rook Monoids.* Preliminary report.

The starting point for this talk is the observation that the rook monoid R_n indexes the set of $B \times B$-orbits on the monoid $M_n(k)$ of $n \times n$ matrices over the field k. Here $B \subseteq Gl_n(k)$ is the subgroup of upper-triangular $n \times n$ matrices. But there is a much more general statement. If M is an irreducible, reductive monoid with unit group G, and Borel subgroup $B \subseteq G$, then the set of two-sided B-orbits $R(M) = B\backslash M/B$ has the natural structure of a finite inverse monoid with unit group W, the Weyl group of G.

Many familiar combinatorial notions "come from" R_n (e.g. Catalan numbers, Sterling numbers). And many of these can be generalized to $R(M)$, for any reductive monoid M.

But there are many interesting geometric questions here. (1) What if M is associated with the wonderful embedding? (2) What if $M \setminus \{0\}$ is rationally smooth? (3) What kind of combinatorics on $R(M)$ arises from the cell decomposition of M, and how do we compute the dimension of each cell? (Received August 22, 2012)

1083-05-100 **Alex Fink*** (arfink@ncsu.edu) and **Luca Moci**. *Matroids over rings.*

We introduce the notion of a matroid over an arbitrary commutative ring. When this ring is a field, we recover matroids; when a DVR, we get essentially tropical Plücker vectors i.e. valuated matroids; and when the ring is $\mathbb{Z}$ we get arithmetic matroids. More generally, when the ring is Dedekind we can define all of the usual matroid

properties and operations, and can compute the universal deletion-contraction invariant. (Received August 22, 2012)

1083-05-113 **Alex Engstrom**, **Patricia Hersh*** (plhersh@ncsu.edu) and **Bernd Sturmfels**. *Toric cubes.*

A toric cube is a subset of the standard cube defined by binomial inequalities. These basic semialgebraic sets are precisely the images of standard cubes under monomial maps. We study toric cubes from the perspective of topological combinatorics. Explicit decompositions as CW-complexes are constructed. Their open cells are interiors of toric cubes and their boundaries are subcomplexes. The motivating example of a toric cube is the edge-product space in phylogenetics, and our work generalizes results known for that space. (Received August 23, 2012)

1083-05-117 **Ruth Davidson*** (redavids@ncsu.edu) and **Patricia Hersh**. *Using EL-shellability to characterize finite semimodular and geometric lattices.*

An edge labeling of a Hasse diagram is often used to show that the order complex of a finite poset is shellable, a method pioneered by Björner and Wachs. We characterize finite semimodular and geometric lattices as finite lattices admitting certain families of edge labelings. These results fit into a similar paradigm as Peter McNamara's 2003 characterization of supersolvable lattices as those finite lattices admitting lexicographic shellings induced by S_n-EL-labelings. This is joint work with Patricia Hersh. (Received August 24, 2012)

1083-05-124 **Jim Haglund*** (jhaglund@math.upenn.edu), 209 S. 33rd St., math dept., UPenn, Philadelphia, PA 19104-6395. *Rook Theory and Eulerian Polynomials.*

Riordan showed that Eulerian polynomials and their multiset generalizations are special cases of rook polynomials. In this talk we discuss how multivariate stable Eulerian polynomials arise in the solution of a question of the speaker, Ono, and Wagner on zeros of permanents, a question which was motivated by rook theory. We also outline some recent results of the speaker and Visontai which introduce other multivariate extensions of Eulerian polynomials. (Received August 24, 2012)

1083-05-138 **Arvind Ayyer**, **Steven Klee** and **Anne Schilling*** (anne@math.ucdavis.edu), Department of Mathematics, One Shields Ave, University of California, Davis, CA 95616. *Combinatorial Markov chains on linear extensions.*

We consider generalizations of Schützenberger's promotion operator on the set L of linear extensions of a finite poset of size n. This gives rise to a strongly connected graph on L. By assigning weights to the edges of the graph in two different ways, we study two Markov chains, both of which are irreducible. The stationary state of one gives rise to the uniform distribution, whereas the weights of the stationary state of the other has a nice product formula. This generalizes results by Hendricks on the Tsetlin library, which corresponds to the case when the poset is the anti-chain and hence $L = S_n$ is the full symmetric group. We also provide explicit eigenvalues of the transition matrix in general when the poset is a rooted forest. This is shown by proving that the associated monoid is R-trivial and then using Steinberg's extension of Brown's theory for Markov chains on left regular bands to R-trivial monoids. This is joint work with Arvind Ayyer and Steve Klee.

Time permitting we will also mention new models (sandpile and TOOM models), where the techniques of R-trivial monoids seem to work. This is based on joint work with Arvind Ayyer and Nicolas M. Thiéry. (Received August 26, 2012)

1083-05-165 **Alexander Engström*** (alexander.engstrom@aalto.fi), Aalto University, Helsinki, Finland. *A nerve lemma for gluing incoherent discrete Morse functions.*

Sometimes it is easy to find optimal Morse functions for parts of a CW complex, but difficult for all of it. I will present a new nerve lemma for gluing them together. This lemma is just a way to black box some relevant but intricate machinery from diagrams of spaces, and should be a flexible tool that easily could be applied. (Received August 27, 2012)

1083-05-166 **Alexander Engström** (alexander.engstrom@aalto.fi) and **Matthew T. Stamps*** (matthew.stamps@aalto.fi), Aalto University, Helsinki, Finland. *Betti diagrams from graphs.*

The emergence of Boij-Söderberg theory has given rise to new connections between combinatorics and commutative algebra. Herzog, Sharifan, and Varbaro recently gave a surprising proof that every Betti diagram of an ideal with a k-linear minimal resolution arises from the Stanley-Reisner ideal of a simplicial complex. In this talk, we present a bijective correspondence between Betti diagrams of algebras with 2-linear resolutions and threshold graphs. We also discuss the more general statement that every Betti diagram of a module with a

2-linear minimal resolution arises from a direct sum of edge algebras of threshold graphs. The main observation is that these Betti diagrams are the lattice points in a family of normal reflexive polytopes that are constructed recursively from threshold graphs. (Received August 27, 2012)

1083-05-170 **Uwe Nagel*** (uwe.nagel@uky.edu), University of Kentucky, Department of Mathematics, 715 Patterson Office Tower, Lexington, KY 40506. *Betti numbers of some edge ideals.*

Extending results about Ferrers and threshold graphs, we discuss the multigraded Betti numbers of edge ideals associated to skew shapes. They admit a combinatorial interpretation. (Received August 27, 2012)

1083-05-177 **Nicholas A. Loehr*** (nloehr@vt.edu) and **Jeffrey B. Remmel** (jremmel@ucsd.edu). *Rook-by-Rook Rook Theory.*

Rook theory studies placements of non-attacking rooks on generalized chessboards. A celebrated theorem of Goldman, Joichi, and White provides a simple criterion for deciding when two boards of partition shape are rook-equivalent. We will describe a bijective proof of this theorem in which non-attacking rook placements on one board are algorithmically matched to placements on the other board. Our construction is based on the famed Involution Principle of Garsia and Milne. If time permits, we will discuss p, q-analogues, bijective proofs of hit equivalence, connections to q, t-Catalan numbers, and a related construction of Foata and Schutzenberger. (Received August 27, 2012)

1083-05-195 **Rafael S. González D'León*** (dleon@math.miami.edu) and **Michelle L. Wachs**. *On the (co)homology of the poset of weighted partitions.* Preliminary report.

V. V. Dotsenko and A. S. Khoroshkin introduced the poset of weighted partitions Π_n^w to prove Koszulness of the Koszul dual operads $\mathcal{L}ie^2$ and ${}^2\mathcal{C}om$ using the poset technique of B. Vallete. We construct an explicit correspondence between natural generating sets of $\mathcal{L}ie_2(n)$, the multilinear component of the free Lie algebra with two compatible brackets, and $WH^{top}(\Pi_n^w)$, the top Whitney cohomology module of Π_n^w. This induces an $\mathfrak{S}_n$-isomorphism between $\mathcal{L}ie_2(n)$ and $WH^{top}(\Pi_n^w)$ tensored with the sign representation of $\mathfrak{S}_n$. We use our computation of the Möbius invariant of maximal intervals and the fact, shown by H. Strohmayer, that the poset is Cohen-Macaulay to recover the result of Dotsenko, Khoroshkin and F. Liu that $\dim \mathcal{L}ie_2(n) = n^{n-1}$. Our correspondence can be seen as a bicolored version of the correspondence of M. Wachs relating the cohomology of the poset of partitions Π_n and $\mathcal{L}ie(n)$. We introduce then a new bicolored version of the comb basis for $\mathcal{L}ie(n)$ and discuss a bicolored Lyndon basis already introduced by Liu. We also compute some algebraic invariants of Π_n^w such as the rank and characteristic polynomials. (Received August 27, 2012)

1083-05-200 **Marisa Hughes** and **Ed Swartz*** (ebs22@cornell.edu). *Matroids and Quotients of Spheres, II.*

We will continue the story which connects linear quotients of spheres by abelian groups to matroids. Previous results include finite elementary abelian p-groups and real tori. The most recent chapter comes from M. Hughes thesis and includes the $\mathbb{Z}/p\mathbb{Z}$ homology of linear quotients of spheres by orientable actions of any finite abelian group. (Received August 27, 2012)

1083-05-206 **John Shareshian*** (shareshi@math.wustl.edu) and **Russ Woodroofe** (rwoodroofe@math.msstate.edu). *Noncontractibility of order complexes of coset posets.*

Let G be a finite group. The coset poset $C(G)$ is the set of all cosets of all proper subgroups of G, partially ordered by inclusion. The order complex $\Delta C(G)$ is the simplicial complex whose k-dimensional faces are the chains of length k in $C(G)$. K. S. Brown asked whether $\Delta C(G)$ can be contractible. Using P. A. Smith theory, we show that if no composition factor of G is an alternating group, then $\Delta C(G)$ has nontrivial reduced homology and is therefore not contractible. (Received August 28, 2012)

1083-05-211 **Axel Hultman*** (axel.hultman@liu.se). *Permutation statistics of products of random transpositions.*

Let stat be a permutation statistic. Consider a subset of the symmetric group $T \subseteq S_n$. What is the expected value of stat on a product of t randomly chosen uniformly distributed elements of T?

We describe a simple method to answer such questions. Specifically, if T is the set of transpositions (or, more generally, any union of conjugacy classes), the problem boils down to expanding a certain "average statistic" as a linear combination of irreducible S_n-characters. This turns out to be a simple combinatorial exercise for many standard statistics; examples include the inversion number, major index, descent number, (weak) excedance number and various versions of cycle numbers.

The technique extends earlier joint work with Eriksen. Other specializations recover results by Sjöstrand, Jackson and Alon-Kozma. (Received August 28, 2012)

1083-05-218 **Martha Yip*** (myip@math.upenn.edu), 209 South 33rd Street, Philadelphia, PA 19104.
Rook placements and nilpotent matrices over finite fields.

The group of n by n upper-triangular nilpotent matrices with entries in the finite field with q elements have Jordan forms indexed by partitions $\lambda \vdash n$. Using a recursive formula for the number $F_\lambda(q)$ of matrices of fixed Jordan type, we obtain a combinatorial formula for $F_\lambda(q)$ as a sum over rook placements. (Received August 28, 2012)

1083-05-227 **Anton Dochtermann*** (anton@math.miami.edu), 1365 Memorial Dr., Coral Gables, FL 33146. *Laplacian ideals, arrangements, and resolutions.* Preliminary report.

The lattice ideal of the Laplacian matrix of a graph G provides an algebraic perspective on the combinatorial dynamics of the Abelian Sandpile Model and the more general Riemann-Roch theory of G. The generators of this ideal form a Gröbner bases with respect to a certain term order, and the associated initial ideals have well-known connections to G-parking functions. We study resolutions of these initial ideals and show that, at least under certain conditions on G, a minimal free resolution is supported on the bounded subcomplex of a hyperplane section of the graphical arrangement of G. It is conjectured that these complexes also support resolutions for the Laplacian lattice ideal itself. This generalizes constructions from Postnikov and Shaprio (for the case of the complete graph) and connects to work of Manjunath and Sturmfels, and Perkinson on the commutative algebra of Sandpiles. Time permitting we will discuss some connections to the topology of generalized partition posets. This is joint work with Raman Sanyal. (Received August 28, 2012)

1083-05-231 **Jeffrey E Liese***, jliese@calpoly.edu, and **B K Miceli** and **J B Remmel**. *Connection coefficients between generalized rising and falling factorial bases.*

Several product formulas for rook polynomials have appeared somewhat recently in the literature. For example, Goldman, Joichi and White showed that for any Ferrers board $B = F(b_1, \ldots, b_n)$,

$$\prod_{i=1}^{n} (x + b_i - (i-1)) = \sum_{k=0}^{n} r_k(B)(x)\downarrow_{n-k} . \tag{1}$$

where $r_k(B)$ is the k-th rook number of B and $(x)\downarrow_k = x(x-1)\cdots(x-(k-1)$ is the usual falling factorial polynomial

Similar formulas where $r_k(B)$ is replaced by some appropriate generalization of the k-th rook number and the falling factorial is replaced by a slightly more general rising or falling factorial polynomial, such as $(x)\uparrow_{k,j} = x(x+j)\cdots(x+j(k-1))$ or $(x)\downarrow_{k,j} = x(x-j)\cdots(x-j(k-1))$ can be found in the work of Goldman and Haglund, Remmel and Wachs, Haglund and Remmel and Briggs and Remmel.

Miceli and Remmel then provided a fairly robust rook model that specializes to the types of product formulas mentioned above including q and p, q analogues. In joint work with Miceli and Remmel, we aimed to use this rook model to provide combinatorial interpretations for the connection coefficients between generalized rising and falling factorial polynomials and this talk will focus on these interpretations. (Received August 29, 2012)

1083-05-233 **Stuart Margolis**, **Franco Saliola** and **Benjamin Steinberg*** (bsteinberg@ccny.cuny.edu). *Poset topology and global dimension of algebras arising in combinatorics.*

Bidigare, Hanlon and Rockmore used the representation theory of hyperplane face monoids to analyze Markov chains. This was further investigated by Diaconis and Brown. Brown generalized the whole theory to a class of monoids called left regular bands. Walks on matroids, oriented matroids, and real and complex hyperplane arrangements fit into this class. Further work was done by Björner, Chung and Graham.

In this talk we consider the global dimension of left regular band algebras. This is intimately connected with poset topology and Leray numbers of simplicial complexes. (Received August 29, 2012)

06 ► Order, lattices, ordered algebraic structures

1083-06-23 **Ryan Therkelsen*** (rtherkelsen@bellarmine.edu). *Some Properties of Generalized Partitions Relating to the Rook Monoid.*

For an integer n, a partition is usually described as a sequence of positive integers that sum to n, recorded in non-increasing order. In this talk, I will describe what happens when the non-increasing convention is relaxed (in a specific way). The poset consisting of these "generalized partitions", under dominance order, has some nice properties and arises naturally in the study of a certain decomposition of the set of $n \times n$ matrices. This

decomposition is most easily described in terms of conjugacy classes of the Gauss-Jordan elements of the rook monoid. (Received July 17, 2012)

1083-06-238 **Mahir Bilen Can** (mcan@tulane.edu) and **Tim Twelbeck*** (ttwelbec@tulane.edu), 7532 Hampson Street, New Orleans, LA 70118. *Lexicograpic shellability of partial involutions.*

Partial involutions arise naturally as representatives of certain Borel orbit closures and form a partially ordered set under set inclusion. In this talk we present a proof of the fact that the poset of partial involutions is lexicographically shellable. If time permits we determine the Eulerian intervals of this poset and indicate how partial involutions might be used to obtain new labelings on involutions. (Received September 04, 2012)

13 ► Commutative rings and algebras

1083-13-13 **David E. Dobbs*** (dobbs@math.utk.edu), Department of Mathematics, University of Tennessee, Knoxville, TN 37996-1320, and **Jay Shapiro** (jshapiro@gmu.edu), Department of Mathematics, George Mason University, Fairfax, VA 22030-4444. *A note on complete rings of quotients and McCoy rings.* Preliminary report.

If a (commutative unital) ring A is reduced and coincides with its total quotient ring, then A satisfies Property A (that is, A is a McCoy ring) if and only if the inclusion of A in its complete ring of quotients $C(A)$ is a survival extension. The "if" assertion fails if one deletes the hypothesis that A is reduced. This is shown by using the idealization construction to construct a suitable ring A and then identifying its complete ring of quotients (which turns out to be a related idealization). Related characterizations of von Neumann regular rings are also given with the aid of the going-down property GD of ring extensions. For instance, a ring A is von Neumann regular if and only if A is a reduced McCoy ring that coincides with its total quotient ring such that $A \subseteq C(A)$ satisfies GD. (Received June 28, 2012)

1083-13-26 **Jay Shapiro*** (jshapiro@gmu.edu) and **David E Dobbs**. *Going-down in Monoid Rings.*

Let $A \subseteq B$ be nonzero commutative unital rings and $T \subseteq S$ torsion-free cancellative abelian monoids. We show that if S is of rank 1, then $A[T] \subseteq A[S]$ satisfies GD (the going-down property). An example shows that the preceding conclusion fails if S and T each have rank 2, with A the field with two elements. Also, if S is of rank 1, then $A[S] \subseteq B[S]$ satisfies GD if and only if the extension of polynomial rings $A[X] \subseteq B[X]$ satisfies GD. (Received July 19, 2012)

1083-13-27 **Jia Huang*** (huang338@umn.edu), Minneapolis, MN 55455. *A gluing construction for polynomial invariants.*

We give a *polynomial gluing construction* of two groups $G_X \subseteq GL(\ell, \mathbb{F})$ and $G_Y \subseteq GL(m, \mathbb{F})$ which results in a group $G \subseteq GL(\ell + m, \mathbb{F})$ whose ring of invariants is isomorphic to the tensor product of the rings of invariants of G_X and G_Y. In particular, this result allows us to obtain many groups with polynomial rings of invariants, including all p-groups whose rings of invariants are polynomial over $\mathbb{F}_p$, and the finite subgroups of $GL(n, \mathbb{F})$ defined by sparsity patterns, which generalize many known examples. (Received July 20, 2012)

1083-13-30 **Thomas G. Lucas*** (tglucas@uncc.edu), Department of Mathematics & Statistics, University of North Carolina Charlotte, 9201 University City Blvd, Charlotte, NC 28223. *The Clique Ideal Property.*

For a commutative ring R, one can form a graph $\Gamma(R)^*$ where the vertices are the zero divisors of R (including 0) and the edges are the pairs $\{a, b\}$ where $ab = 0$ with $a \neq b$. A clique of $\Gamma(R)^*$ is a nonempty subset X such that $ab = 0$ for all $a \neq b$ in X. If R is a finite ring, there is always a maximum clique of $\Gamma(R)^*$ – a clique X such that $|X| \geq |Y|$ for all cliques Y. We say that a finite ring R has the clique ideal property if each maximum clique of $\Gamma(R)^*$ is an ideal of R. For each positive integer $n > 1$, the ring $R = \mathbb{Z}_n[x]/(x^2)$ is a finite ring with the clique ideal property. In contrast, $\mathbb{Z}_n$ has the clique ideal property if and only if n is either a perfect square or a prime. (Received July 23, 2012)

1083-13-34 **Yuri Villanueva*** (yvillanu@fau.edu) and **Lee Klingler**. *Rings of integer-valued polynomials and derivatives on finite sets.*

For D an integral domain with field of fractions K and E a subset of K, the ring $\mathrm{Int}(E, D) = \{f \in K[X] \mid f(E) \subseteq D\}$ of integer-valued polynomials on E has been well studied. In particular, when E is a finite subset of D, Chapman, Loper, and Smith, as well as Boynton and Klingler, obtained a bound on the number of elements needed to generate a finitely generated ideal of $\mathrm{Int}(E, D)$ in terms of the corresponding bound for D. We obtain

analogous results for $\mathrm{Int}^{(r)}(E,D) = \{f \in K[X] \mid f^{(k)}(E) \subseteq D \text{ for all } 0 \leq k \leq r\}$, for finite E and fixed integer $r \geq 1$. (Received July 27, 2012)

1083-13-38 **Rafael H. Villarreal*** (vila@math.cinvestav.mx), CINVESTAV-IPN, Departamento de Matematicas, Apartado Postal 14-740., 07000 Mexico D.F., Mexico. *Vanishing ideals of sets parametrized by monomials.*

Let $K = \mathbb{F}_q$ be a finite field and let X be a subset of a projective space $\mathbb{P}^{s-1}$, over the field K, which is parameterized by monomials. We study the degree and the regularity of $I(X)$, the vanishing ideal of X, and show that in certain cases one can give explicit formulas for these invariants. The main cases we consider are when X is parametrized by the edges of a graph or when X is parametrized by monomials of the form $t_1^{v_1}, \ldots, t_n^n$ (in the second case, X is a degenerate torus and $I(X)$ turns out to be closely related to the toric ideal of a certain monomial curve that depends on the field K). The motivation to study these invariants comes from algebraic coding theory. (Received August 04, 2012)

1083-13-42 **Dan D. Anderson*** (dan-anderson@uiowa.edu), Department of Mathematics, The University of Iowa, Iowa City, IA 52242, and **Malik Bataineh**, Department of Mathematics and Statistics, Jordan University of Science and Technology, Irbid, 22110, Jordan. *Idealization and Polynomials.*

Let R be a commutative ring and M an R-module. Let R(+)M be the idealization or trivial extension of R and M. We investigate the relationship between polynomial identities satisfied by R and by R(+)M. (Received August 06, 2012)

1083-13-46 **Hailong Dao***, 405 Snow Hall, 1460 Jayhawk Blvd, University of Kansas, Lawrence, KS 6604. *Some problems in combinatorial commutative algebra motivated by commutative algebra.*

We will describe several problems in commutative algebra that have interesting combinatorial interpretations when specialized to the case of Stanley-Reisner rings: bounding projective dimensions, equality of ordinary and symbolic powers. Some of the results are joint work with Craig Huneke and Jay Schweig. (Received August 08, 2012)

1083-13-48 **Louiza Fouli**, Department of Mathematical Sciences, New Mexico State University, Las Cruces, NM 88003, and **Kuei-Nuan Lin*** (knlin@math.ucr.edu), Department of Mathematics, University of California, Riverside, Riverside, CA 92521. *Rees Algebras of Square-Free Monomial Ideals.*

We study the defining equations of the Rees algebras of square-free monomial ideals in a polynomial ring over a field. We establish the defining equations of the Rees algebra when an ideal is minimally generated by at most 5 elements. We also provide new classes of ideals of linear type. We propose the construction of a graph, namely the generator graph of an ideal, where the monomial generators serve as vertices for the graph. We show that when an ideal is a square-free monomial ideal and the generator graph of the ideal is the graph of a disjoint union of trees and graphs with unique odd cycles then it is an ideal of linear type. (Received August 08, 2012)

1083-13-50 **Laura Ghezzi*** (lghezzi@citytech.cuny.edu). *Hilbert coefficients of parameter ideals relative to a module.*

The set of the first Hilbert coefficients of parameter ideals relative to a module M over a Noetherian local ring codes for significant information about its structure.

We discuss noteworthy properties such as that of Cohen-Macaulayness, Buchsbaumness, and of having finitely generated local cohomology. In particular, Vasconcelos Conjecture on the vanishing of the first Hilbert coefficient $e_1(Q, M)$ is solved affirmatively, where Q is a parameter ideal of M.

This is joint work with S. Goto, J. Hong, K. Ozeki, T.T. Phuong, and W.V. Vasconcelos. (Received August 09, 2012)

1083-13-60 **Michael R DiPasquale*** (dipasqu1@illinois.edu), Department of Mathematics, 1409 W. Green Street, Urbana, IL 61801. *Shellability and Freeness of Continuous Splines.*

We provide an example of a shellable polyhedral complex $\mathcal{P}$ in $\mathbb{R}^2$ such that the module of continuous splines $C^0(\hat{\mathcal{P}})$ is not a free module over the polynomial ring in three variables, answering a question raised by Schenck in his paper *Equivariant Chow Cohomology of Non-Simplicial Toric Varieties*. (Received August 14, 2012)

1083-13-65 **Sang B. Lee*** (sblee@smu.ac.kr), Department of Mathematics Education, Sangmyung University, Seoul, 110-743, South Korea. *Absolutely pure modules over certain domains.* Preliminary report.

Absolutely pure modules are defined as modules that are pure in its injective hull. They are divisible in general and coincide with divisible modules if the underlying rings are Pruefer domains.Also they are exactly injective modules over Noetherian domains. We consider a class of domains which are strictly weaker than Pruefer domains, the domains over which every injective modules have weak dimension less than or equal to 1. We first give equivalent definition of these domains and then try to characterize absolutely pure modules among divisibles modules employing the concepts of weak-injective modules introduced by the author.

We also look into several open problems concerning dual modules in some sense to Absolutely pure modules, i.e., pure-injective modules. (Received August 16, 2012)

1083-13-69 **Christina L. Eubanks-Turner*** (ceturner@louisiana.edu), University of Louisiana at Lafayette, Department of Mathematics, P.O. Box 41010, Lafayette, LA 70504, and **Aihua Li** (lia@mail.montclair.edu), Montclair State University, 1 Normal Ave, Montclair, NJ 07043. *Graphical Properties of the Bipartite Subgraph of Spec($\mathbb{Z}[x]$).* Preliminary report.

In this work we investigate the graphical properties of the bipartite subgraph of Spec($\mathbb{Z}[x]$). By approaching prime spectra from a new perspective we hope to gain more insight about the ring. We have results concerning such fundamental graph theoretical properties as connectivity, girth, diameter and circumference for the bipartite subgraph of Spec($\mathbb{Z}[x]$). As the graph associated with Spec($\mathbb{Z}[x]$) is an infinite graph, we consider some infinite graph theory aspects of the spec graph like homogeneity and ray behavior. (Received August 16, 2012)

1083-13-72 **Kurt Herzinger*** (kurt.herzinger@usafa.edu), 2354 Fairchild Dr., Suite 6D124, USAF Academy, CO 80840-6252. *Using numerical semigroups to investigate torsion in tensor products.*

Let $R = k[[t^{n_1}, \ldots, t^{n_e}]]$ where k is a field and n_i is a positive integer for $1 \leq i \leq e$. The valuation of R is the numerical semigroup $S =< n_1, \ldots, n_e >$. Many properties of R are reflected in S making numerical semigroups a useful tool for studying certain questions concerning one dimensional local Noetherian domains. In this talk we will see how numerical semigroups can be used to investigate torsion in the tensor product of a fractional ideal I, generated by monomials, over R with its inverse. The technique involves looking at the inequality $\mu_R(I)\mu_R(I^{-1}) \geq \mu_R(II^{-1})$ in the corresponding relative ideal and its dual over S. (Received August 17, 2012)

1083-13-84 **Jose Martinez-Bernal** and **Susan Morey*** (morey@txstate.edu), Department of Mathematics, Texas State University, 601 University Dr., San Marcos, TX 78666, and **Rafael H. Villarreal**. *Associated Primes of Powers of Edge Ideals.*

If I is an ideal of a Noetherian ring R, then Broadmann showed in 1979 that the sets of primes associated to the powers of I, that is the sets $\mathrm{Ass}(R/I^t)$, stabilize for large t. In general, it is not known where the stabilization occurs, which primes are in the stable set, or how the sets of associated primes behave prior to stabilization. Of particular interest is finding classes of ideals for which the associated primes are particularly well-behaved in that the sets of associated primes of the powers of the ideal form an ascending chain, that is, $\mathrm{Ass}(R/I^t) \subseteq \mathrm{Ass}(R/I^{t+1})$ for all t. The main result of this talk will be to show that if R is a polynomial ring and I is a square-free monomial ideal generated in degree two, that is, I is the edge ideal of a graph, then the sets of associated primes form an ascending chain. The proof uses combinatorial results and a theorem of Berge from graph theory as well as algebraic techniques. (Received August 20, 2012)

1083-13-86 **Evan Houston***, eghousto@uncc.edu, and **Abdeslam Mimouni** and **Mi Hee Park**. *Integrally closed domains which admit only finitely many star operations.*

We give a complete characterization of integrally closed domains which admit only finitely many star operations. Such domains must be Prüfer domains and must be "almost h-local" in several ways. (Received August 20, 2012)

1083-13-92 **Olgur Celikbas*** (celikbaso@missouri.edu). *Test Modules.*

I will discuss some basic homological properties of a certain class of finitely generated modules, called test modules, that are defined in terms of the vanishing of Tor over commutative Noetherian rings. This is joint work with Hailong Dao and Ryo Takahashi. (Received August 21, 2012)

1083-13-97 **Jared L Painter*** (jpainter@hbu.edu), 7502 Fondren Rd, Houston, TX 77074.
Interactions Between Free Resolutions, Bass Numbers, and Tor-Algebra Structures for Monomial Ideals. Preliminary report.

We will discuss properties of the the minimal free resolution for R/I where $R = \Bbbk[x, y, z]$ and $I \subseteq \mathfrak{m}^2$ is an $\mathfrak{m}$-primary monomial ideal. We will also see how we can use properties of the resolution to describe the lower Bass numbers and the Tor-algebra structure for R/I. To achieve this we use recent work of L. Avramov, where he classifies the behavior of Bass numbers of embedding codepth 3 commutative local rings. His classification relies on a corresponding classification of their respective Tor algebras, which is comprised of 5 categories. Using Avramov's classification of the Tor algebra structures, along with their respective Bass series we will learn how to identify Tor algebra structure and lower Bass numbers for R/I by simpliy inspecting the minimal free resolution of R/I. In addition we will describe a class of ideals with a specific Tor-Algebra structure which was previously unknown. (Received August 22, 2012)

1083-13-103 **Petter Andreas Bergh**, **David A. Jorgensen*** (djorgens@uta.edu) and **Steffen Oppermann**. *On products in negative cohomology for n-Calabi-Yau categories.*

We investigate the structure of the Z-graded cohomology rings of objects in n-Calabi-Yau triangulated categories. Almost by definition these cohomology rings possess a natural duality. In particular, the stable endomorphism ring of a finitely generated module over a finite dimensional symmetric k-algebra is a Z-graded k-algebra that it possesses a natural duality between its positive and negative sides. A consequence of this is that if the non-negative part of the endomorphism ring has a regular sequence of central elements of length 2, then all products between elements of negative degree are trivial. As a corollary we show this holds for the Tate-Hochschild cohomology ring of a symmetric k-algebra. We'll also show the same results hold over a commutative zero-dimensional Gorenstein ring. This is based on joint work with Petter Bergh and Steffen Oppermann. (Received August 22, 2012)

1083-13-107 **Ryan Karr*** (karr@uwp.edu), University of Wisconsin-Parkside, 330 Greenquist Hall, Kenosha, WI 53141. *Torsion-free cancellation for subrings of* $\mathbb{Z} \oplus \cdots \oplus \mathbb{Z}$. Preliminary report.

In 1983, L. Levy published some results concerning subrings of $\mathbb{Z} \oplus \cdots \oplus \mathbb{Z}$. In this talk, we'll look into direct-sum cancellation of torsion-free modules, with respect to a large class of these subrings. Whereas all of Levy's examples of failure of cancellation involved ideals, our examples will show that higher-rank modules must be considered, even for subrings of $\mathbb{Z} \oplus \mathbb{Z} \oplus \mathbb{Z}$. (Received August 23, 2012)

1083-13-109 **Trevor E McGuire*** (tmcgui1@lsu.edu), Louisiana State University, Department of Mathematics, 304 Lockett, Baton Rouge, LA 70803-0001. *Free Resolutions of Ideals with Monomial and Binomial Generators.*

Free resolutions of $S = k[x_1, ..., x_n]$-modules are widely studied. In the field of combinatorial commutative algebra, resolutions of S-ideals generated only by monomials or only by binomials have been given a combinatorial interpretation in terms of simplicial complexes. In fact, simple algorithms have been given that generate these free resolutions. In this talk, we will describe a combinatorial algorithm that can generate a free resolution of an S-ideal that is generated by both monomial and binomial terms. This algorithm will use the newly defined Lattice Translated Buchberger Graph, which is a generalization of the Buchberger graph one can use to resolve a monomial S-ideal. (Received August 23, 2012)

1083-13-111 **Shane P. Redmond***, 313 Wallace Bldg, 521 Lancaster Ave, Richmond, KY 40475. *Is it time for a new definition of the zero-divisor graph?* Preliminary report.

Given a commutative ring R with 1, the most common definition of the zero-divisor graph $\Gamma(R)$ defines the vertices to be the nonzero zero-divisors of R and defines two *distinct* vertices x and y to be adjacent when $xy = 0$. This definition does not allow a "loop," or an edge from a vertex x to itself, indicating an element x such that $x^2 = 0$. Given a finite commutative ring R with 1, it is a straightforward exercise to create $\Gamma(R)$ with or without looped vertices. A solution to the inverse problem, using only $\Gamma(R)$ to identify the ring R, will be presented (up to certain local factors) for graphs that have loops. The importance these loops can play in the future study of ideal-based graphs, a natural generalization of the zero-divisor graph, will also be investigated. (Received August 23, 2012)

1083-13-119 **David Cook II*** (dcook8@nd.edu), Department of Mathematics, 255 Hurley Building, University of Notre Dame, Notre Dame, IN 46656-4618, and **Uwe Nagel**. *The weak Lefschetz property for type two monomial algebras.*

We determine which type two monomial algebras in three variables have the weak Lefschetz property in characteristic zero and, in some cases, positive characteristic. The level, characteristic zero case was recently settled by Boij, Migliore, Miró-Roig, Nagel, and Zanello in a surprisingly intricate and lengthy proof. Our proof, which gives the level case as a corollary, uses a connection to the enumeration of signed lozenge tilings of finite regions of the triangular lattice. (Received August 24, 2012)

1083-13-126 **Ela Celikbas**, **Christina Eubanks-Turner** and **Sylvia M Wiegand*** (swiegand@math.unl.edu), Math. Dept. UNL, 329 Avery Hall, Lincoln, NE 68588. *Prime ideals in quotients of mixed power series-polynomial rings.* Preliminary report.

We investigate the partially ordered set of prime ideals in rings of the form $R[[x]][y]/Q$ and $R[y][[x]]/Q$, where R is a one-dimensional Noetherian domain, x and y are variables, and, in each "fraction", Q is a height-one prime ideal of the numerator. (Received August 24, 2012)

1083-13-135 **Warren Wm. McGovern*** (warren.mcgovern@fau.edu), H.L. Wilkes Honors College, 5353 Parkside Dr., Jupiter, FL 33458. *p-extensions.*

This is joint work with two of my former students M.L. Knox and P. Bhattacharjee. We call an extension of rings, say $R \leq S$ to be a p-extension if for every $s \in S$ there is an $r \in R$ such that $sS = rS$. This notion is a generalization of the well-known (regular) localization. We will motivate the talk with examples and discuss passage of certain kinds of ring/ideal-theoretic properties. We will also discuss what we know about p-extensions in the context of rings of continuous real-valued functions. (Received August 25, 2012)

1083-13-137 **Hal Schenck**, **Alexandra Seceleanu** and **Javid Validashti*** (jvalidas@illinois.edu). *Syzygies and Singularities of Tensor Product Surfaces of Bidegree* $(2,1)$.

Consider the polynomial ring $R = \mathsf{k}[s,t,u,v]$ over an algebraically closed field k. Regard R as a bigraded k-algebra, in which s,t have degree $(1,0)$ and u,v have degree $(0,1)$. Let f_0, f_1, f_2, f_3 be bihomogeneous polynomials of degree $(2,1)$ with no common zeros on $\mathbb{P}^1 \times \mathbb{P}^1$ and I the ideal generated by the f_i's. In a joint work with H. Schenck and A. Seceleanu we classify all possible minimal free resolutions of R/I and we relate the syzygies of the f_i's to the singularities of the projective surface S in $\mathbb{P}^3$ parametrized by the f_i's over $\mathbb{P}^1 \times \mathbb{P}^1$. These resolutions play a key role in determining the implicit equation for S. 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. (Received August 26, 2012)

1083-13-144 **Hailong Dao** and **Jay Schweig***, jay.schweig@okstate.edu. *Projective Dimension and Graph Domination Parameters.*

Often studied in network theory, the domination number of a finite graph G is the least cardinality of a subset S of its vertices such that any vertex not in S is adjacent to a vertex in S. Other domination parameters have been defined in similar ways. We show that these parameters applied to G arise naturally in bounding the projective dimension of the associated edge ideal. Through Hochster's formula, these bounds allow us to easily recover and sometimes strengthen existing results on graph independence complexes. (Received August 26, 2012)

1083-13-145 **Christopher A. Francisco**, **Jeffrey Mermin** and **Jay Schweig***, jay.schweig@okstate.edu. *Poset-Borel Ideals.*

A monomial ideal I in $S = k[x_1, \ldots, x_n]$ is *Borel* if $\frac{x_i}{x_j} m \in I$ whenever m is a monomial in I, x_j divides m, and $i < j$. If Q is a poset on $[n]$, we say a monomial ideal in S is *Q-Borel* if the above holds whenever $i < j$ in Q. Thus every monomial ideal is Q-Borel for some Q, and Borel ideals are C-Borel, where C is the n-element chain $1 < 2 < \cdots < n$. We examine principal Q-Borel ideals, and show how information about such ideals (such as their associated primes) may be gleaned from examining the structure of the associated poset. Finally, we give a minimal resolution of ideals which are "almost" Borel, in that they are Q-Borel for a poset very close to a chain. (Received August 26, 2012)

1083-13-155 **Susan Marie Cooper*** (s.cooper@cmich.edu), Department of Mathematics, Central Michigan University, Pearce Hall, Room 221, Mt. Pleasant, MI 48859. *Fat Points On Grids.* Preliminary report.

One way to study the extent to which sets of points and their subsets differ is to compare their Hilbert functions. In a 1985 paper, Davis-Geramita-Orecchia give a formula which relates the Hilbert functions of a reduced complete intersection, a subset and its complement inside the complete intersection. This formula has been

applied in a wide-variety of situations. It is natural to want a similar formula for non-reduced points. In this talk we will look at this problem for fat points whose support is a subset of a complete intersection constructed on a grid. (Received August 26, 2012)

1083-13-157 **Madhav P Sharma*** (msharma2@fau.edu). *Maximally Prüfer rings.* Preliminary report.
A commutative ring R is said to be a Prüfer ring if every finitely generated regular ideal is invertible, and is said to be a locally Prüfer ring if R_P is a Prüfer ring for every prime ideal P of R. Jason Boynton showed that the class of locally Prüfer rings is smaller than the class of Prüfer rings. We call the ring R maximally Prüfer if R_m is Prüfer for every maximal ideal m of R, and we show that the class of such rings lies properly between Prüfer rings and locally Prüfer rings. (Received August 26, 2012)

1083-13-171 **David Cook II** and **Uwe Nagel*** (uwe.nagel@uky.edu), University of Kentucky, Department of Mathematics, 715 Patterson Office Tower, Lexington, KY 40506. *Monomial ideals and lozenge tilings.* Preliminary report.
We discuss an approach for studying monomial ideals in three variables via lozenge tilings of certain planar regions. It provides combinatorial interpretations for the weak Lefschetz property and the semistability of syzygy bundles.

This is joint work with David Cook II who will discuss an application for level algebras of type two. (Received August 27, 2012)

1083-13-178 **Augustine B O'Keefe*** (augustine.okeefe@uky.edu), Department of Mathematics, University of Kentucky, 715 Patterson Office Tower, Lexington, KY 40506-0027, and **Huy Tai Ha**. *A sufficient condition for Cohen-Macaulay edge rings.* Preliminary report.
Given a discrete graph $G = (V, E)$ one can construct an associated toric ring called the edge ring of G, denoted $K[G]$. The development of a dictionary between the combinatorial structure of the graph and the algebraic structure of the associated ring is of great interest. In this talk we discuss a sufficient condition on the graph G so that the edge ring $K[G]$ satisfies the Cohen-Macaulay condition. (Received August 27, 2012)

1083-13-184 **Greg G. Oman*** (goman@uccs.edu), 1420 Austin Bluffs Parkway, Colorado Springs, CO 80918. *Rings whose multiplicative endomorphisms are power functions.*
Let R be a ring. Then R is called an *E-ring* provided every additive endomorphism of R is given by multiplication by a scalar (that is, if for every endomorphism f of $(R, +)$, there exists $r \in R$ such that $f(x) = rx$ for all $x \in R$). Thus, in a sense, the E-rings are the rings for which all additive endomorphisms are "canonical". Such rings are well-studied in the literature. In this talk, we consider the multiplicative analog of this notion. Let R be a commutative ring with identity, and let n be a positive integer. Then the power function $f(x) := x^n$ is easily seen to be 0-preserving monoid endomorphism of the structure $(R, \cdot, 0, 1)$. Say that a commutative ring R with identity is a *P-ring* provided every 0-preserving multiplicative monoid endomorphism (as above) is equal to a power function (i.e. every such endomorphism is "canonical"). We determine the P-rings up to isomorphism. (Received August 27, 2012)

1083-13-194 **Hariharan Ananthnarayan** and **Ela Celikbas*** (celikbase@missouri.edu), 109A Math Sciences Bldg, Mathematics Department, University of Missouri, Columbia, MO 65203, and **Zheng Yang**. *Decomposing a Gorenstein Artin ring as a Connected Sum.* Preliminary report.
For Gorenstein Artin k-algebras R and S where k is a field, the connected sum, $R\#_kS$, is a quotient of the classical fiber product $R \times_k S$. We show that certain Gorenstein local k-algebras decompose as connected sums. We generalize structure theorems given by Sally, Elias and Rossi that show two types of Gorenstein local k-algebras are connected sums. (Received August 27, 2012)

1083-13-202 **Chris Francisco**, **Jeff Mermin*** (mermin@math.okstate.edu) and **Jay Schweig**. *Generalizing the Borel condition.*
We introduce the idea of a monomial ideal being Borel with respect to a poset Q, and study standard commutative algebraic invariants (such as resolutions and primary decompositions) from this perspective. We attempt to use the poset structure of Q to interpolate between the theory of Borel-fixed ideals (which are Borel with respect to the chain) and the theory of arbitrary monomial ideals (which are Borel with respect to the antichain). (Received August 28, 2012)

1083-13-204 **Tài Hà** and **Russ Woodroofe*** (rwoodroofe@math.msstate.edu), Department of Mathematics & Statistics, 175 President Circle, Starkville, MS 39762. *Regularity of clutters with collages.*

Hà and Van Tuyl showed that if I is an edge ideal of a graph, then the regularity of R/I is at most the matching number of the graph. Indeed, the regularity of R/I is bounded by the minimum size of a maximal matching of the graph. In joint work with Tài Hà, we give an extension of this bound from graphs to clutters (hypergraphs). A main step is to find the correct generalization of matching, the *collages* of the title. (Received August 28, 2012)

1083-13-212 **K Alan Loper*** (loper.4@osu.edu), 1179 University Drive, Newark, OH 43055, and **Carmelo Finocchiaro**. *Viewing an ultrapower as an extension of a commutative ring.* Preliminary report.

Let D be a commutative domain and let D* be an nonprincipal ultrapower of D over some infinite index set. We investigate the differences between the prime spectrum of D and the prime spectrum of D*. Special emphasis will be on the structure of rings of integer-valued polynomial rings over almost Dedekind domains. (Received August 28, 2012)

1083-13-217 **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. *A geometric approach to atomicity and factorization in an integral domain.*

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)

1083-13-226 **Jennifer Biermann*** (jvbierma@lakeheadu.ca), **Christopher Francisco**, **Huy Tài Hà** and **Adam Van Tuyl**. *Colorings of simplicial complexes and vertex decomposability.*

In attempting to understand how combinatorial modifications alter algebraic properties of monomial ideals, several authors have investigated the process of adding "whiskers" to graphs. The first and the fourth authors developed a similar construction to build a vertex decomposable simplicial complex Δ_χ from a coloring χ of the vertices of a simplicial complex Δ. In this talk, we will discuss this construction for colorings of subsets of the vertices, and how it can be used to strengthen and give new proofs for results of the second and third author. (Received August 28, 2012)

14 ► Algebraic geometry

1083-14-1 **Henry K. Schenck***, University of Illinois, 1409 Green St., Urbana, IL. *From Approximation Theory to Algebraic Geometry: the ubiquity of splines.*

Piecewise polynomial functions on a simplicial complex (splines) are fundamental objects in mathematics, with applications ranging from approximation theory and numerical analysis to algebraic geometry, where they appear as the equivariant Chow ring of a toric variety.

For a fixed simplicial complex $\Delta \subseteq \mathbb{R}^n$, the set of splines of smoothness r and polynomial degree at most k is a vector space $C^r_k(\Delta)$, and a fundamental question in approximation theory is to determine the dimension of this vector space. In 1973, Strang conjectured a formula for the dimension $C^1_2(\Delta)$ when Δ is planar. Billera solved the conjecture in 1987 using homological techniques. Further progress on the planar case was made by Alfeld-Schumaker, who obtained an exact formula for the dimension of $C^r_k(\Delta)$, when $k \geq 3r+1$. I'll spend most of the talk giving an overview of the problem and describing how homological algebra comes into the picture. Many of the techniques available in the simplicial case do not extend to the setting of polyhedral complexes, and I'll wrap up the talk with a discussion of recent progress on the dimension question for polyhedral splines (part of this work is collaboration with T. McDonald) (Received March 25, 2011)

1083-14-22 **Martha E. Precup*** (mprecup@nd.edu). *An Affine Paving of Hessenberg Varieties.*

Hessenberg varieties are closed subvarieties of the full flag variety. Examples of Hessenberg varieties include both the Springer and flag varieties. We prove that Hessenberg varieties corresponding to nilpotent elements

which are regular in a Levi factor are paved by affines. As a consequence, we generalize results of Tymoczko asserting that Hessenberg varieties corresponding to regular nilpotent elements are paved by affines. We then provide a partial reduction from paving Hessenberg varieties for arbitrary elements to paving those corresponding to nilpotent elements, recovering Tymoczko's result that all Hessenberg varieties corresponding to elements of $\mathfrak{gl}_n(\mathbb{C})$ are paved by affines. (Received July 11, 2012)

1083-14-77 **Jimmy Shan***, Department of Mathematics, University of Illinois Urbana-Champaign, Urbana, IL 61801. *Local Dimension of C^2 Tetrahedral Splines.*

Alfeld, Schumaker and Whiteley determined the dimension of C^1 generic tetrahedral splines for degree $k \geq 8$. We analyze the local dimension of C^2 tetrahedral splines, where local dimension means that the tetrahedral complex has a single interior vertex. The dimension depends on subtle geometry of the fatpoints corresponding to the con guration of the hyperplanes adjacent to the interior vertex. A key tool is the classi cation of the relevant fatpoint ideals by Geramita, Harbourne and Migliore. (Received August 18, 2012)

1083-14-136 **Corey Irving***, Department of Mathematics and Comp. Science, Santa Clara University, 500 El Camino Real, Santa Clara, CA 95053. *Wachspress Varieties.* Preliminary report.

We examine a variety defined using barycentric coordinates of polygons. Barycentric coordinates express the points of a polygon as convex combinations of the vertices, and are frequently used in geometric modelling. For an N-gon they are a collection of N functions on the polygon. We focus on one type of barycentric coordinates, Wachspress coordinates, that are rational functions. Wachspress coordinates thus define a rational map to $\mathbb{P}^{N-1}$. We study the Zariski closure of the image of this map and describe its defining equations in terms of properties of the polygon. (Received August 25, 2012)

1083-14-173 **Hal Schenck*** (schenck@math.uiuc.edu), 1409 W. Green St, Urbana, IL 61801, and **Hiroaki Terao** and **Masahiko Yoshinaga**. *Logarithmic vector fields and curve configurations.*

Let $\mathcal{A} = \bigcup_{i=1}^{r} C_i \subseteq \mathbb{P}^2$ be a collection of smooth plane curves, such that each singular point is quasihomogeneous. We prove that if C is a smooth curve such that each singular point of $\mathcal{A} \cup C$ is also quasihomogeneous, then there is an elementary modification of rank two bundles, which relates the $\mathcal{O}_{\mathbb{P}^2}$–module of vector fields on $\mathbb{P}^2$ tangent to $\mathcal{A}$ to the module of vector fields tangent to $\mathcal{A} \cup C$. This yields an inductive tool for studying the splitting of these bundles, depending on the geometry of the divisor $\mathcal{A}|_C$ on C. (Received August 27, 2012)

1083-14-207 **Marc Chardin*** (chardin@math.jussieu.fr), Institut de mathématiques, UPMC, 4, place Jussieu, F-75005 Paris, France. *Torsion of the symmetric algebra and images of rational maps.*

In this lecture, a way of computing the image of a rational map using knowledge on the resolution of the symmetric algebra will be presented. In this setting, the method was initiated by Jean-Pierre Jouanolou, and further developed by him, by Laurent Busé and by myself. The origin of this method is the work of people in Geometric Modeling on this question, motivated by a simple question : how to represent the intersection of two surfaces parametrized by rational functions ? Their approach was first put on firm mathematical bases by David Cox and collaborators. The key point in this approach is to control the torsion in the symmetric algebra, which also has other interesting applications. The results I will present are joint work with Laurent Busé, Jean-Pierre Jouanolou and Aron Simis. (Received August 28, 2012)

1083-14-236 **Mahir Bilen Can** (mcan@tulane.edu), **Michael O. Joyce*** (mjoyce3@tulane.edu) and **Benjamin J. Wyser** (bwyser@illinois.edu). *Complete Quadrics and Colored Symmetric Rooks* Preliminary report.

We discuss the weak Bruhat order on the variety of complete quadrics and show how it leads to interesting combinatorics that can be described in terms of colored symmetric rooks. These objects parameterize the orbits of a Borel subgroup acting on the variety of complete quadrics, and understanding the combinatorics of the weak order leads to interesting identities that give a factorization of certain multiplicity-free sums of Schubert polynomials. (Received September 04, 2012)

15 ► Linear and multilinear algebra; matrix theory

1083-15-9 **Lateef Adewale Kareem*** (adewale@kfupm.edu.sa), Petroleum Engineering Department, King Fahd University of Petroleum and, Minerals, Saudi Arabia. *Characteristic Equation and Determinant of a Null Matrix.*

A new method of determining the characteristic equation of a matrix was developed. This new method presents the coefficients of the characteristic equation as the sums of determinants of smaller (co-diagonal) sub matrices within the matrix. It identifies a connection between the coefficients (sum of determinant) and sum of cofactors, and by extension of this connection provides a proof that the determinant of a null matrix is 1, the determinant of an identity matrix. Keywords: Characteristic equations, matrix and determinant, co-diagonal sub matrix, sum of determinant and cofactors, null matrix, identity matrix. (Received June 10, 2012)

1083-15-132 **Randall R. Holmes*** (holmerr@auburn.edu) and **Avantha Kodithuwakku**. *Orthogonal bases of Brauer symmetry classes of tensors for the dihedral group (Part 1).* Preliminary report.

Necessary and sufficient conditions are given for the existence of an orthogonal basis consisting of standard (decomposable) symmetrized tensors for the class of tensors symmetrized using an irreducible Brauer character of the dihedral group. Part 1 covers background and results in the case of degree-one Brauer characters. (Received August 25, 2012)

1083-15-161 **Randall R. Holmes** and **K. A. A. Indika*** (kaa0006@auburn.edu). *Orthogonal bases of Brauer symmetry classes of tensors for the dihedral group (Part 2).* Preliminary report.

Necessary and sufficient conditions are given for the existence of an orthogonal basis consisting of standard (decomposable) symmetrized tensors for the class of tensors symmetrized using an irreducible Brauer character of the dihedral group. Part 2 covers results in the case of degree-two irreducible Brauer characters, as well as some results for projective indecomposable characters and symmetrizers corresponding to Osima idempotents. (Received August 26, 2012)

1083-15-176 **Wen Yan*** (wenyanmath@gmail.com), Department of Mathematics, Tuskegee, AL 36088, and **Durmus Bozkurt** and **Tin-Yau Tam**. *Singular values and eigenvalues of complex skew symmetric, symplectic and Hamiltonian matrices.*

We give a complete relation between the singular values and eigenvalues of a complex skew symmetric matrix in terms of multiplicative majorization and double occurrences of singular values and eigenvalues. Similar studies are given for symplectic and Hamiltonian matrices (Received August 27, 2012)

16 ► Associative rings and algebras

1083-16-4 **Milen T. Yakimov*** (yakimov@math.lsu.edu), Louisiana State University, Department of Mathematics, Baton Rouge, LA. *The Andruskiewitsch-Dumas conjecture.*

The automorphism groups of noncommutative associate algebras are often difficult to describe. Precise answers are only known for very particular algebras. In some cases Joseph, Alev, Shestakov, and Umirbaev proved the existence of wild automorphisms. On the other hand, Andruskiewitsch and Dumas conjectured that the positive parts of all quantized universal enveloping algebras of simple Lie algebras have small automorphism groups which can be described explicitly, but this was only proved in four cases.

We will outline a proof of the latter conjecture in full generality. The key step in this proof is a rigidity theorem for an important class of "bifinite" automorphisms of completions of quantum tori. It has a broad range of applications. It allows one to control the automorphism groups of large classes of associative algebras, for instance quantum cluster algebras. (Received August 28, 2012)

1083-16-15 **Ali Mohammadian*** (ali_m@ipm.ir), School of Mathematics, Institute for Research, in Fundamental Sciences (IPM), P.O. Box 19395-5746, Tehran, Iran. *The Structure of Zero-Divisor Graphs.* Preliminary report.

The set of zero-divisors in a ring R does not have any obvious algebraic structure in general. If R is commutative, then this set is just a semi-group under multiplication. For this reason, it seems appropriate to use non-algebraic methods to study this set. One such approach involves the so-called zero-divisor graph. The zero-divisor graph $\Gamma(R)$ of a ring R is the graph whose vertices consist of the non-zero zero-divisors of R in which two distinct vertices a and b are adjacent if and only if either $ab = 0$ or $ba = 0$. In exploring the relationship between a finite ring R and the graph $\Gamma(R)$, various problems are considered as follows: (i) The isomorphism problem: "For

two finite rings R and S, are rings R and S isomorphic when graphs $\Gamma(R)$ and $\Gamma(S)$ are isomorphic?" (ii) The classification problem: "For a finite ring R, when $\Gamma(R)$ has a special graph-theoretic property?" In this talk, we characterize all non-local finite rings whose zero-divisor graphs are complete multipartite. We also provide a classification of the finite rings whose zero-divisor graphs have cut vertices. Finally, we present some open problems and conjectures about the zero-divisor graphs. (Received July 02, 2012)

1083-16-37 **Gary F. Birkenmeier*** (gfb1127@louisiana.edu), **Jin Yong Kim** (jykim@khu.ac.kr) and **Jae Keol Park** (jkpark@pusan.ac.kr). *Right primary and nilary rings and ideals.*

In this paper, we investigate various generalizations of the primary concept to noncommutatice rings. In particular, we determine conditions on a ring R such that: (1) each ideal of R is a finite intersection of generalized primary ideals; (2) R is a direct sum of generalized primary rings; or (3) R is a generalized triangular matrix ring with generalized primary rings on the main diagonal. Examples are provided to illustrate and delimit our results. (Received August 02, 2012)

1083-16-47 **Martin Lorenz*** (lorenz@temple.edu). *Torus actions on noncommutative algebras.*

Let G be an algebraic torus that acts rationally by automorphisms on an associative algebra R. The G-action induces a stratification of the prime spectrum of R which was first studied by Goodearl and Letzter. For a noetherian algebra R, Goodearl and Letzter have shown that the strata of the spectrum of R are isomorphic to the spectra of certain commutative Laurent polynomial algebras. In this talk, I will sketch a new proof of this result which works for arbitrary algebras R. (Received August 08, 2012)

1083-16-83 **Houssein El Turkey*** (houssein@ou.edu), Department of Mathematics, The University of Oklahoma, Norman, OK 73019, and **Jonathan Kujawa** (kujawa@ou.edu), Department of Mathematics, The University of Oklahoma, Norman, OK 73019. *Presenting Schur Superalgebras.*

Following the work of Doty and Giaquinto on both the classical and the quantum Schur algebras, we obtain a nice presentation by generators and relations of the Schur superalgebra. The Schur superalgebra is a result of the Schur-Weyl duality between the symmetric group and the Lie superalgebra $\mathfrak{gl}(m|n)$. The presentations we obtain are compatible with the Serre-type presentation of the universal enveloping superalgebra of $\mathfrak{gl}(m|n)$. We also discuss our analogous results in the quantum setting. (Received August 20, 2012)

1083-16-85 **James J Zhang***, Box 354350, Department of Mathematics, University of Washington, Seattle, WA 98195. *Invariant Theory of finite group actions on down-up algebras.* Preliminary report.

We explore a noncommutative version of Kac-Watanabe and Gordeev theorem for noetherian graded down-up algebras. This is joint work with Ellen Kirkman and James Kuzmanovich. (Received August 20, 2012)

1083-16-91 **Kenneth Chan**, Department of Mathematics, Box 354350, Seattle, WA 98185, **Ellen Kirkman**, Department of Mathematics, P.O. Box 7388, Winston-Salem, NC 27109, **Chelsea Walton***, Department of Mathematics, Cambridge, MA 02144, and **James Zhang**, Department of Mathematics, Box 354350, Seattle, WA 98195. *Quantum binary polyhedral groups and their actions on quantum planes.*

We classify quantum analogues of finite subgroups of SL2(k), and study their actions on Artin-Schelter regular algebras of global dimension two. (Received August 21, 2012)

1083-16-99 **Martina Balagovic*** (martina.balagovic@york.ac.uk). *Category $\mathcal{O}$ for Rational Cherednik Algebras in Positive Characteristic.*

To a complex reflection group W, its reflection representation $\mathfrak{h}$, and a collection of parameters t, c, one can associate the rational Cherednik algebra $H_{t,c}(W, \mathfrak{h})$ as an associative, noncommutative algebra encoding the structure of Dunkl operators. There is a natural definition of category $\mathcal{O}$, and a question of calculating characters of irreducible objects in it. In this talk I will discuss the case when the underlying field is of positive characteristic. This is joint work with Harrison Chen. (Received August 22, 2012)

1083-16-102 **Aaron D Lauda*** (lauda@math.usc.edu), Department of Mathematics, University of Southern California, 3620 S. Vermont Ave, KAP 108, Los Angeles, CA 90089-2532. *Odd structures arising from categorified quantum groups.*

Khovanov homology is a categorification of the Jones polynomial that paved the way for other categorifications of quantum link invariants. The theory of categorified quantum groups provides a representation theoretic explanation of these homological link invariants via the work of Webster and others. Surprisingly, the categorification of the Jones polynomial is not unique. Ozsvath, Rasmussen, and Szabo introduced an "odd" analog of Khovanov

homology that also categorifies the Jones polynomial, and the even and odd categorification are not equivalent. In this talk I will explain joint work with Alexander Ellis, Mikhail Khovanov, and Heather Russell that aims to develop odd analogs of categorified quantum groups to give a representation theoretic explanation of odd Khovanov homology. These odd categorifications lead to surprising new "odd" structures in geometric representation theory including odd analogs of the cohomology of the Grassmannian and Springer varieties. (Received August 22, 2012)

1083-16-112 **M. Susan Montgomery*** (smontgom@math.usc.edu), Department of Mathematics, University of Southern California, 3620 S. Vermont Ave, KAP 104, Los Angeles, CA 90089-2532. *Computing Frobenius-Schur indicators for doubles of groups.*

Let H be a semisimple Hopf algebra over $\mathbb{C}$ with an irreducible representation V. For each integer n, $1 \leq n \leq Exp(H)$, one may define $\nu_n(V)$, the n^{th} Frobenius-Schur indicator of V, analogously to the classical case of finite groups. Indicators are *gauge invariants*, that is, an invariant of the tensor category of representations, and have had many nice applications.

Here we discuss the question as to when all of the indicators for $H = D(G)$ are integers. This is always true for G itself, although for Hopf algebras in general they lie in the ring of n^{th} cyclotomic integers [KSZ].

In recent work with M. Iovanov and G. Mason, we show it is true for many groups, such as when G is alternating or symmetric, $PSL_2(q)$, M_{11}, M_{12}, and regular nilpotent groups. However we show there is an irregular nilpotent group of order 5^6 with non-integer indicators.

A harder question is when are the indicators of $D(G)$ non-negative integers. This has been shown for G any dihedral group by M. Keilberg, and for $G = S_n$ for $n \leq 10$ by R. Courter. (Received August 23, 2012)

1083-16-153 **Garrett Johnson*** (johnsongw@cua.edu) and **Christopher Nowlin** (cnowlin@gmail.com). *Quantum Affine Schubert Cells and FRT-Bialgebras.*

The aim of this talk is to draw connections between certain quantum Schubert cell algebras and universal FRT-bialgebras. The universal bialgebra construction of Faddeev, Reshetikhin, and Takhtajan is an approach to obtaining a q-deformation of the coordinate ring of regular functions on an algebraic group G. On the other hand, a quantum Schubert cell algebra $\mathcal{U}_q^+[w]$ associated to an element w in the Weyl group of a simple Lie algebra $\mathfrak{g}$ is a deformation of the universal enveloping algebra $\mathcal{U}(\mathfrak{n}_+ \cap w.\mathfrak{n}_-)$. We show that certain multi-parameter quantum affine Schubert cells, and quotients thereof, map isomorphically onto certain distinguished subalgebras of FRT-bialgebras. This is joint work with Christopher Nowlin. (Received August 26, 2012)

1083-16-158 **Yiqiang Li*** (yiqiang@buffalo.edu), 244 Mathematics Building, Department of Mathematics, University at Buffalo, SUNY, Buffalo, NY 14260. *On quantum matrix algebras.*

The quantum matrix algebras of Faddeev-Reshetikhin-Takhtajan and Dipper-Donkin are realized geometrically by using double partial flag varieties. The relation of the construction with that of De Concini, Kac, and Procesi will be discussed. (Received August 26, 2012)

1083-16-160 **Wuxing Cai**, Guangzhou, Peoples Rep of China, and **Naihuan Jing*** (jing@math.ncsu.edu), Raleigh, NC 27695. *Vertex operators and Jack Polynomials.*

We give an iterative method to realize general Jack functions from Jack functions of rectangular shapes. We first show some cases of Stanley's conjecture on positivity of the Littlewood-Richardson coefficients, and then use this method to give a new realization of Jack functions. We also show in general that vectors of products of Jack vertex operators form a basis of symmetric functions. In particular this gives a new proof of linear independence for the rectangular and marked rectangular Jack vertex operators. Thirdly a generalized Frobenius formula for Jack functions was given and was used to give new evaluation of Dyson integrals and even powers of Vandermonde determinant (Received August 26, 2012)

1083-16-205 **Siu-Hung Ng*** (rng@iastate.edu). *Total indicators of the representations of quasi-Hopf algebras.* Preliminary report.

Frobenius-Schur indicators of the representations of finite groups are well-known to be integers, but not for general semisimple Hopf algebras. In this talk, we consider a special sum of Frobenius-Shcur indicators, called the total indicator, which is always a non-negative integer. We will discuss the non-vanishing property of the total indicators for Hopf algebras, and its categorical implications.

The talk is based on an ongoing joint work with Gongxiang Liu (Received August 28, 2012)

1083-16-229 **Rajesh S Kulkarni***, Department of Mathematics, Wells Hall, 619 Red Cedar Road, East Lansing, MI 48824, and **Yusuf Mustopa**, Department of Mathematics, Carney Hall, Room 301, Boston College, Chestnut Hill, MA 02467-3806. *Representations of Clifford algebras and Ulrich bundles on hypersurfaces.*

For a form f of degree d in n-variables, there is an algebra called the Clifford algebra C_f which is universal for linearizing f in matrices. The matrix representations of C_f are in bijection with certain vector bundles (called Ulrich bundles) on closely related hypersurfaces. We discuss recent results in case of Ulrich bundles on cubic and quartic surfaces (which correspond to ternary forms of degree 3 and 4). We also show how noncommutative algebras are used in providing nontrivial examples of smooth ACM curves on some hypersurfaces of higher dimension. This is joint work with Yusuf Mustopa (and partly with Emre Coskun). (Received August 28, 2012)

17 ► Nonassociative rings and algebras

1083-17-16 **Jonathan R Kujawa***, Dept. of Mathematics, University of Oklahoma, Norman, OK 73019-3103. *The Generalized Kac-Wakimoto Conjecture.*

Using a new point of view coming from low-dimensional topology, a few years ago Geer, Patureau-Mirand, and I introduced a generalization of the Kac-Wakimoto conjecture for Lie superalgebras. We discuss the proof of this conjecture for the classical Lie superalgebras and some consequences. (Received July 02, 2012)

1083-17-49 **Kailash C. Misra***, Department of Mathematics, North Carolina State University, Raleigh, NC 27695-8205, and **Toshiki Nakashima**. *$A_n^{(1)}$-Geometric Crystal corresponding to Dynkin index $i = 2$ and its ultra-discretization.*

Let g be an affine Lie algebra with index set $I = \{0, 1, 2, \cdots, n\}$ and g^L be its Langlands dual. It is conjectured that for each $i \in I \setminus \{0\}$ the affine Lie algebra g has a positive geometric crystal whose ultra-discretization is isomorphic to the limit of certain coherent family of perfect crystals for g^L. We prove this conjecture for $i = 2$ and $g = A_n^{(1)}$. In particular, we give explicit construction of the $A_n^{(1)}$-geometric crystal with positive structure and prove that its ultra-discretization is isomorphic to the crystal $B^{2,\infty}$. (Received August 09, 2012)

1083-17-118 **Jörg Feldvoss*** (jfeldvoss@southalabama.edu), Department of Mathematics and Statistics, University of South Alabama, Mobile, AL 36688-0002, **Salvatore Siciliano** (salvatore.siciliano@unisalento.it), Dipartimento di Matematica e 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. *Split abelian chief factors and Lie algebra cohomology.*

In this talk we explain the relation between the multiplicities of split abelian chief factors of finite-dimensional Lie algebras and 1-cohomology. In particular, we obtain a characterization of solvable Lie algebras over fields of prime characteristic in terms of the vanishing of 1-cohomology or in terms of the multiplicities of split abelian chief factors. The analogues of these results are well known in the modular representation theory of finite groups. An important tool in the proof of these results is a refinement of a non-vanishing theorem of Seligman for the 1-cohomology of non-solvable finite-dimensional Lie algebras in prime characteristic. All this is joint work with Salvatore Siciliano and Thomas Weigel. (Received August 24, 2012)

1083-17-130 **Sean I Clark*** (sic5ag@virginia.edu), **David Hill** and **Weiqiang Wang**. *Towards canonical bases for quantum Kac-Moody superalgebras.* Preliminary report.

In this talk, we will briefly discuss the construction of the canonical basis of $\mathfrak{osp}(1|2)$ and explain how this motivates a new definition of quantum Kac-Moody superalgebras. Then we will discuss recent joint work with Hill and Wang towards a general approach to constructing canonical bases for Kac-Moody superalgebras. (Received August 25, 2012)

1083-17-140 **Vyacheslav Futorny** and **Dimitar Grantcharov*** (grandim@uta.edu), Department of Mathematics, UT Arlington, Arlington, TX 76021. *Weight modules of infinite dimensional Weyl algebras.*

We provide a classification and explicit realization of the simple weight modules of the infinite dimensional complex Weyl algebra. The realization of these modules is in terms of shifted Laurent polynomials. The injective envelopes and the projective covers of the simple objects in the category of weight modules are obtained as well. (Received August 26, 2012)

1083-17-143 **Ben L. Cox*** (coxbl@cofc.edu), Deparment of Mathematics, College of Charleston, 66 George St, Charleston, SC 29401, **Vyacheslav Futorny**, Universidade de Sao Paulo, Instituto de Matematica e Estatistica, Rua do Matao, 1010, Sao Paulo, Brazil, and **Renato A. Martins**, Universidade de Sao Paulo, Instituto de Matematica e Estatistica, Rua do Matao, 1010, Sao Paulo, Brazil. *Virasoro action on Imaginary Verma modules and the operator form of the KZ-equation.*

We define a Virasoro algebra action on imaginary Verma modules for affine $\mathfrak{sl}(2)$ and use it to construct an analogue of the Knizhnik-Zamolodchikov equation in the operator form. This action is not described in terms of Sugawara operators. Both these results are formed from a realization of imaginary Verma modules in terms of sums of partial differential operators. (Received August 26, 2012)

1083-17-148 **Drazen Adamovic*** (adamovic@math.hr), Bijenicka 30, 10 000 Zagreb, Croatia. *On representations of affine vertex algebras outside the category $\mathcal{O}$.*

We shall study certain categories of modules for vertex algebras of affine type which are larger than the category $\mathcal{O}$. We are motivated by fusion rules analysis and the problem of classification of irreducible representations of affine Lie algebras of certain types. Particular emphasis will be put on simple vertex algebras associated to admissible representations and representations at the critical level. Connection with certain irrational, C_2 cofinite vertex algebras will be also discussed. (Received August 26, 2012)

1083-17-149 **Yiqiang Li*** (yiqiang@buffalo.edu), 244 Mathematics Building, University at Buffalo, SUNY, Buffalo, NY 14260. *A geometric realization of modified quantum algebras.*

A geometric construction of Lusztig's modified quantum algebra of symmetric type is presented by using certain localized equivariant derived categories of double framed representation varieties of quivers. (Received August 26, 2012)

1083-17-151 **Ben Cox*** (coxbl@cofc.edu), 66 George St., Math Dept., College of Charleston, Charleston, SC 29401, **Vyacheslav Futorny**, Math Department, University of Sao Paulo, Sao Paulo, Brazil, and **Juan Tirao**, Faculty of Mathematics, Astronomy and Physics, National University of Cordoba, 5000, Cordoba, Argentina. *DJKM algebras, their Universal Central Extension and Orthogonal Polynomials.* Preliminary report.

We describe families of polynomials arising in the study of the universal central extensions of Lie algebras introduced by Date, Jimbo, Kashiwara, and Miwa in their work on the Landau-Lifshitz differential equation. Two of the families of polynomials we show satisfy certain forth order linear differential equations and are orthogonal. (Received August 26, 2012)

1083-17-159 **Naihuan Jing*** (jing@math.ncsu.edu), Raleigh, NC 27695. *Principal Realizations of the Yangian Y(sl(n)).*

I will discuss the new realization for Yangians of the general linear types and their twisted analogs (jointly with C. Bai, M.-L. Ge and M. Liu). In recent applications of Yangians to quantum computations, the Bell states are found to be suitable in the Yangian representations. We will generalize this notion and prove that the princial basis indeed simply the Yangian action. (Received August 26, 2012)

1083-17-172 **Brian D. Boe***, Mathematics Department, University of Georgia, Athens, GA 30602, and **Jonathan R. Kujawa** and **Daniel K. Nakano**. *Thick subcategories for classical Lie superalgebras.* Preliminary report.

D. Benson, S. Iyengar, and H. Krause have developed a general framework for classifying thick subcategories in triangulated categories. A motivating example is the classification in the case of the stable category of finitely generated modules for a finite group G over an algebraically closed field k of characteristic p. Their general setup involves a graded commutative noetherian ring R (e.g., the cohomology ring $H^\bullet(G,k)$) acting on a compactly generated triangulated category $\mathbf{T}$. A key ingredient is a support theory, taking objects in $\mathbf{T}$ to subsets of the variety $X = \operatorname{Spec} R$.

We investigate a more general scenario where there need not be a ring R whose Spec provides the requisite geometry, but yet there is *some* variety X and a suitable support theory on $\mathbf{T}$ taking values in X. Such a situation arises in the setting of a classical Lie superalgebra $\mathfrak{g} = \mathfrak{g}_{\overline{0}} \oplus \mathfrak{g}_{\overline{1}}$, the category $\mathcal{C}$ of $\mathfrak{g}$-modules which are finitely semisimple over $\mathfrak{g}_{\overline{0}}$ (or a related module category), and $\mathbf{T} = \operatorname{stmod}(\mathcal{C})$. We discuss the application of our approach to classifying the thick subcategories in this setting. (Received August 27, 2012)

1083-17-183 **Bojko Bakalov*** (bojko_bakalov@ncsu.edu) and **Todor Milanov** (todor.milanov@ipmu.jp). *$\mathcal{W}$-constraints for the total descendant potential of a simple singularity.*

Simple singularities are classified by Dynkin diagrams of type ADE. Let $\mathfrak{g}$ be the corresponding finite-dimensional Lie algebra, and W its Weyl group. The set of $\mathfrak{g}$-invariants in the basic representation of the affine Kac–Moody algebra $\hat{\mathfrak{g}}$ is known as a $\mathcal{W}$-algebra and is a subalgebra of the Heisenberg vertex algebra $\mathcal{F}$. Using period integrals, we construct an analytic continuation of the twisted representation of $\mathcal{F}$. Our construction yields a global object, which may be called a W-twisted representation of $\mathcal{F}$. Our main result is that the total descendant potential of the singularity, introduced by Givental, is a highest weight vector for the $\mathcal{W}$-algebra. (Received August 27, 2012)

18 ► Category theory; homological algebra

1083-18-187 **Radmila Sazdanovic*** (radmilas@math.upenn.edu), University of Pennyslvania, David Rittenhouse Lab., 209 south 33rd street, Philadelphia, PA 19104-6395, and **Vladimir Baranovsky**. *Graph homology and configuration spaces.*

We will discuss the proof of the conjecture due to M. Khovanov relating the algebraic and topological categorification of the chromatic polynomial. We show that there exists a spectral sequence relating the chromatic graph homology defined by L. Helme-Guizon and Y. Rong and the homology of a graph configuration space introduced by M. Eastwood, S. Huggett. (Received August 27, 2012)

1083-18-198 **Joseph P. Brennan*** (joseph.brennan@ucf.edu), Department of Mathematics, University of Central Florida, Orlando, FL 32816, and **Heath M. Martin** (heath.martin@ucf.edu), Department of Mathematics, and Office of Undergraduate Studies, University of Central Florida, Orlando, FL 32816. *Localization of sets.* Preliminary report.

This talk will examine the problem of the representation of the localization of a subcategory of the category of sets in the category of set together with applications to analysis. (Received August 27, 2012)

19 ► K-theory

1083-19-43 **Shrawan Kumar*** (shrawan@email.unc.edu), Department of Mathematics, Chapel Hill, NC 27599-3250. *Positivity in T-Equivariant K-theory of flag varieties associated to Kac-Moody groups.* Preliminary report.

Let G be any symmetrizable Kac-Moody group completed along the negative roots and $G^{min} \subset G$ be the 'minimal' Kac-Moody group. Let B be the standard (positive) Borel subgroup, B^- the standard negative Borel subgroup, $H = B \cap B^-$ the standard maximal torus and W the Weyl group. Let $\bar{X} = G/B$ be the 'thick' flag variety (introduced by Kashiwara) which contains the standard KM flag ind-variety $X = G^{min}/B$. Let T be the quotient torus $H/Z(G^{min})$, where $Z(G^{min})$ is the center of G^{min}.

Let $K_T^{top}(X)$ be the T-equivariant topological K-group of X. Let $\{\psi^w\}_{w\in W}$ be the 'basis' of $K_T^{top}(X)$ given by Kostant-Kumar. Express the product in $K_T^{top}(X)$:

$$\psi^u \cdot \psi^v = \sum_w p_{u,v}^w \psi^w, \quad \text{for } p_{u,v}^w \in R(T).$$

Then, the following result is our main theorem. This generalizes one of the main results of Anderson-Griffeth-Miller (which was conjectured earlier by Graham-Kumar) from the finite to any symmetrizable Kac-Moody case. THEOREM. For any $u, v, w \in W$,

$$(-1)^{\ell(u)+\ell(v)+\ell(w)}\, p_{u,v}^w \in F_+[(e^{-\alpha_1}-1), \ldots, (e^{-\alpha_r}-1)],$$

where $\{\alpha_1, \ldots, \alpha_r\}$ are the simple roots. (Received August 06, 2012)

20 ► Group theory and generalizations

1083-20-56 **Brian Parshall*** (bjp8w@virginia.edu). *Shifted generic cohomology.*

The cohomology of finite groups can be approached via the cohomology of ambient semisimple algebraic groups, by papers by Cline-Parshall-Scott and (later) by Cline-Parshall-Scott-van der Kallen. The notion of generic cohomology arose as an intermediary between finite Chevalley group and algebraic group cohomology obtained through a limiting process.

We report on work with L. Scott and D. Stewart showing that, for irreducible modules as coefficients, the limits can be eliminated in all but finitely many cases. These exceptional cases depend only on the root system and cohomological degree. In fact, for $r \gg 0$, depending on the root system and m, and not on the prime p or the irreducible module L, there are isomorphisms $H^m(G(p^r), L) \cong H^m(G(p^r), L') \cong H^m_{gen}(G, L') \cong H^m(G, L')$, where "gen" refers to generic cohomology and L' is a constructibly determined irreducible "shift" of the irreducible module L for the finite Chevalley group $G(p^r)$. This leads to the notion of a module being "shifted m-generic.". The approach is based on questions raised earlier by Stewart, which are answered here in the cohomology cases. (Received August 13, 2012)

1083-20-57 **Leonard L Scott*** (lls2l@virginia.edu). *Forced gradings and p-filtrations.*
This is joint work with Brian Parshall. A main result is that Weyl modules, for semsimple algebraic groups G in characteristic p, have p-filtrations, when p is at least 2h-2 (with h the Coxeter number) and also sufficiently large that the Lusztig character formula holds for all restricted irreducible modules. "p-filtrations" are defined as having all sections equal to tensor products of restricted irreducible modules with twisted Weyl modules. A main technique involves "forcing" a grading on associated quasi-hereditary algebras by passing to the graded algebras associated to their radical series. Needless to say, a lot of effort is required to make these algebras work in a satisfactory way, even to make them again quasi-heredtary. As time permits, I will discuss applications, including instances where the Koszul property can be obtained for such algebras with a forced grading. The "forcing" approach actually avoids geometric approaches to Koszulity, which are not immediately available in this setting, though it is possible to raise relevant geometric questions (Received August 14, 2012)

1083-20-71 **Zhenheng Li*** (zhenhengl@usca.edu), 471 University Parkway, Aiken, SC 29803. *Bijection between Conjugacy Classes and Irreducible Representations of Finite Inverse Semigroups.*
The representation story of semigroups is long, but one part is missing: whether there is a bijection between the set of conjugacy classes of a finite inverse semigroup S and the set of inequivalent irreducible representations of S over an algebraically closed field? This talk will address this matter. (Received August 16, 2012)

1083-20-152 **Lisa DeMeyer*** (demey1la@cmich.edu), Mathematics Department, 214 Pearce Hall, Central Michigan University, Mount Pleasant, MI 48858, and **Peter Vermeire**. *A simplicial complex for the zero divisor graph of a semigroup.* Preliminary report.
The zero divisor graph of a semigroup is the graph whose vertices are the non-zero zero divisors of the semigroup. Two distinct vertices are adjacent in the graph in case their product is zero. In 2005 a simplicial complex associated to the zero divisor graph of a semigroup was introduced by F. DeMeyer and L. DeMeyer. One goal of this talk is describe the simplicial complex, provide nontrivial examples, and discuss new directions of investigation. (Received August 26, 2012)

1083-20-188 **Martin E Malandro***, Box 2206, Department of Mathematics and Statistics, Sam Houston State University, Huntsville, TX 77341. *Enumeration of finite inverse semigroups.* Preliminary report.
If S is an inverse semigroup, let $E(S)$ denote the meet-semilattice of idempotents of S. We present a fast algorithm which takes a meet-semilattice E and a natural number n and computes the inverse semigroups S of order n up to isomorphism such that $E(S) = E$. Our algorithm can be used to compute $S(n)$, the number of inverse semigroups of order n up to isomorphism, by applying it to the meet-semilattices of orders $1, \ldots, n$. We present the results of this application for some small values of n. (Received August 27, 2012)

22 ► Topological groups, Lie groups

1083-22-79 **Toshiki Nakashima*** (toshiki@sophia.ac.jp), Kioicho 7-1, Chiyoda-ku, Tokyo, 102-8554, Japan. *Decorated Geometric Crystals and Monomial Realizations of Crystals.*
A decoration is a rational function with some invariant properties on a geometric crystal. We shall present the explicit form of a decoration on the geometric crystal $TB^-_{w_0}$ for a classical group G, where T is a maximal torus of G and w_0 is the longest element of the Weyl group. We shall see that the explicit form of the decoration is written in a positive sum of monomials appearing in the monomial realizations of crystal bases. (Received August 19, 2012)

1083-22-82 **Kyu-Hwan Lee*** (khlee@math.uconn.edu), Department of Mathematics, University of Connecticut, U-3005, Storrs, CT 06269-3005, and **Philip Lombardo** (plombardo@sjcny.edu). *Eisenstein Series on Affine Kac-Moody Groups over Function Fields.*

In his pioneering work, H. Garland constructed Eisenstein series on affine Kac-Moody groups over the field of real numbers. He established the convergence of these series, obtained a formula for their constant terms, and proved a functional equation for the constant terms. In this talk, we define Eisenstein series on affine Kac-Moody groups over function fields using an adelic approach. In the course of proving the convergence of these Eisenstein series, we also calculate a formula for the constant terms and prove their convergence and functional equations. (Received August 20, 2012)

1083-22-193 **Myron Minn-Thu-Aye*** (mminnt1@math.lsu.edu). *Multiplicity formulas for perverse coherent sheaves on the nilpotent cone.* Preliminary report.

Bezrukavnikov has shown that the category of perverse coherent sheaves on the nilpotent cone of a complex reductive algebraic group is quasi-hereditary. The Andersen–Jantzen sheaves play an important role, analogous to that of the Verma modules in category $\mathcal{O}$. We describe progress towards computing multiplicities of simple objects in Andersen–Jantzen sheaves. The main tool is an equivalence between perfect complexes on the nilpotent cone and mixed sheaves on the affine Grassmannian. (Received August 27, 2012)

1083-22-215 **Harold Williams*** (harold@math.berkeley.edu). *Cluster Ensembles and the Chamber Ansatz.*

After the introduction of cluster algebras a decade ago, it was quickly discovered that the combinatorial data underlying a cluster algebra encodes a second type of algebraic structure, variously called X-coordinates or coefficients. These are related to the cluster algebra by an abstract monomial transformation, the cluster ensemble map, concrete examples of which had been discovered in Teichmuller theory and discrete integrable systems independently of the perspective of cluster algebras. In this talk we explain how this structure gives a new point of view on the Chamber Ansatz, a key formula in total positivity discovered in the late 90's. Using certain X-coordinates constructed on double Bruhat cells in higher Teichmuller theory, we will see that the Chamber Ansatz is in retrospect a disguised example of the cluster ensemble map. (Received August 28, 2012)

1083-22-223 **Ivan Mirkovic*** (mirkovic@math.umass.edu). *Geometry of Modular Representation Theory and Koszul Duality.*

A Koszul duality structure in representation theory of algebraic groups in positive characteristic was established by Anderson-Jantzen-Soergel. A geometric interpretation was provided by Simon Riche in the context of representations of Lie algebras with the trivial p-character. This talk is about extending the work of Riche to the general p-character. (Received August 28, 2012)

1083-22-225 **Roman Bezrukavnikov*** (bezrukav@math.mit.edu), 77 Massachusetts ave, #2-284, MIT, Cambridge, MA 02139. *Character sheaves on loop groups and endoscopy.*

I will describe a joint project with D. Kazhdan and Y. Varshavsky where we develop an analogue of the notion of a character sheaf for a loop group. The conjectural picture provides a categorical framework for understanding the phenomenon of endoscopy, the results obtained so far provide a geometric approach to known results on depth zero L-packets (studied by Kazhdan-Varshavsky and De Backer-Reeder), new results on projector to the unipotent spectrum of a p-adic group etc. (Received August 28, 2012)

1083-22-237 **Merrick L. Brown*** (merrickb@email.unc.edu). *Saturation in Tensor Product Decomposition of Integrable A ffine $\mathfrak{sl}_2$ Representations.* Preliminary report.

Let $L(\lambda)$, $L(\mu)$, and $L(\nu)$ be integrable highest-weight representations of $\mathfrak{g} = \widehat{\mathfrak{sl}_2}$ so that $\lambda + \mu + \nu$ is an element of the root lattice. We give a simple condition when $L(N\nu) \subset L(N\lambda) \otimes L(N\mu)$ for $N > 0$ in terms of the weight spaces of $L(\lambda)$ and $L(\nu)$. As a consequence, we show that $L(N\nu) \subset L(N\lambda) \otimes L(N\mu)$ implies that $L(2\nu) \subset L(2\lambda) \otimes L(2\mu)$. We approach the tensor product decomposition problem by computing the characters in terms of string functions and using the Weyl-Kac character formula to arrive at branching functions for $\mathfrak{g} \hookrightarrow \mathfrak{g} \oplus \mathfrak{g}$. We then utilize the action of the Virasoro algebra on $L(\lambda) \otimes L(\mu)$ given by the Sugawara construction, as discussed in [Kac-Wakimoto, Adv. in Math. 70], to interpret these branching functions as characters of unitarizable Virasoro modules. This constrains which $L(\nu)$ do not appear in the decomposition of $L(\lambda) \otimes L(\mu)$ and allows us to arrive at a saturation factor of 2. (Received September 04, 2012)

30 ► Functions of a complex variable

1083-30-141 **Jun Hu** and **Susovan Pal*** (susovan97@gmail.com), NJ 08904. *On Boundary regularity and Asymptotic Conformality of Douady-Earle extensions of diffeomorphisms of S^n.*

Let f be a C^1 diffeomorphism of the unit sphere S^n. We show that $\Phi(f)$ is C^1-smooth self map of B^{n+1} which is C^1 upto the boundary of B^{n+1} and in general not asymptotically conformal near the boundary except for $n = 1$. In particular, we show that when f is orientation-preserving and $n = 1, \Phi(f)_z \to 1, \Phi(f)_{\bar{z}} \to 0$, and $\Phi(f)$ is always asymptotically conformal near the boundary. (Received August 26, 2012)

34 ► Ordinary differential equations

1083-34-19 **John Bryce McLeod** and **Susmita Sadhu*** (susmita.sadhu@gmail.com). *An integral equation method to derive uniform asymptotic expansions of solutions of a class of singularly perturbed boundary value problems.*

We will consider a class of singularly perturbed boundary value problems (BVPs):

$$\varepsilon y'' + 2y' + f(y) = 0, \quad y(0) = 0,\ y(A) = 0,$$

where $f \in C^2[0, \infty)$ is a positive function satisfying certain conditions. It can be shown that the BVP admits at most two solutions depending on A. The main goal of this talk is to rigorously prove a uniform asymptotic expansion of the "smaller" solution using an integral equation method, whenever the problem admits two solutions.

To achieve our goal, we will prove an existence result that will ensure a uniform bound on the "smaller" solution and that would lead us to the asymptotics. Indeed, we will prove that for each $A_0 < 2\int_0^\infty dy/f(y)$, there exist $\varepsilon(A_0) > 0$ and positive constants K and C that depend only on A_0 and not on ε, such that if $\varepsilon \in (0, \varepsilon(A_0))$ and $A \in (0, A_0]$ then the problem has a unique solution y satisfying $\|y\| \le K$ and $|\varepsilon y'(0)| \le C$. The proof leads easily to the desired asymptotic expansion. (Received July 03, 2012)

1083-34-51 **John R. Graef** (john-graef@utc.edu), **Lingju Kong** (lingju-kong@utc.edu), **Qingkai Kong** (kong@math.niu.edu) and **Min Wang*** (min-wang@utc.edu), Department of Mathematics, University of Tennessee at Chattanooga, Chattanooga, TN 37343. *Positive solutions of nonlocal fractional boundary value problems.*

The authors study a type of nonlinear fractional boundary value problem with nonlocal boundary conditions. An associated Green's function is constructed. Then a criterion for the existence of at least one positive solution is obtained by using fixed point theory on cones. (Received August 10, 2012)

1083-34-55 **Lingju Kong*** (lingju-kong@utc.edu), Department of Mathematics, University of Tennessee at Chattanooga, Chattanooga, TN 37403, and **John R. Graef** (john-graef@utc.edu), Deparment of Mathematics, University of Tennessee at Chattanooga, Chattanooga, TN 37403. *Existence of positive solutions to a higher order singular boundary value problem with fractional q-derivatives.*

We study the singular boundary value problem with fractional q-derivatives

$$-(D_q^\nu u)(t) = f(t, u),\ t \in (0, 1),$$
$$(D_q^i u)(0) = 0,\ i = 0, \dots, n-2, \quad (D_q u(1) = \sum_{j=1}^{m} a_j (D_q u)(t_j) + \lambda,$$

where $q \in (0, 1)$, $m \ge 1$ and $n \ge 2$ are integers, $n-1 < \nu \le n$, $\lambda \ge 0$ is a parameter, $f : [0, 1] \times (0, \infty) \to [0, \infty)$ is continuous, $a_i \ge 0$ and $t_i \in (0, 1)$ for $i = 1, \dots, m$, and D_q^ν is the q-derivative of Riemann-Liouville type of order ν. Sufficient conditions are obtained for the existence of positive solutions of the problem. Recent results in the literature are extended and improved. Our analysis is mainly based a nonlinear alternative of Leray-Schauder. (Received August 13, 2012)

1083-34-62 **Johnny Henderson** (johnny_henderson@baylor.edu), One Bear Place #97328, Waco, TX 76798, **Xueyan (Sherry) Liu*** (xueyan_liu@baylor.edu), One Bear Place #97328, Waco, TX 76798, **Shawn Sutherland** (shawn_sutherland@baylor.edu), One Bear Place #97328, Waco, 76798, and **Yu Tian** (tianyu2992@163.com), No.10. Xitucheng Road, Haidian District, Beij, Beijing, 100876, Peoples Rep of China. *Positive Solutions for a Second Order Impulsive BVP with Bounded Linear Operator Conditions.*

The authors are concerned about the existence of at least one positive solutions of a second order impulsive boundary value problem with bounded linear operator conditions. A recent functional-operator fixed point

theorem, which is a generalization of Leggett and Williams fixed point theorem, is applied. (Received August 15, 2012)

1083-34-73 **Gangaram S Ladde*** (gladde@usf.edu), Department of Mathematics and Statistics, 4202 East Fowler Avenue, CMC 342, Tampa, FL 33620-5700. *Stochastic Boundary Value Problems of Ito-Doob Type with Applications.* Preliminary report.

By employing the Green's function method, the existence of a solution process of a nonlinear Ito-Doob type stochastic boundary problem is investigated. In addition, the mean-square stability and error estimate results are established. The presented results are applied to investigate the chemical, environmental and physical sciences dynamic processes. Moreover, the effects of random environmental are also illustrated. (Received August 17, 2012)

1083-34-93 **Aghalaya S Vatsala*** (vatsala@louisiana.edu), Department of Mathematics, University of Louisiana at Lafayette, Lafayette, LA 70504-1010, and **Sowmya Muniswamy** and **Donna Sue Stutson**. *Generalized Monotone Method, Numerical Approach for Ordinary and Fractional Differential Equations.* Preliminary report.

Generalized monotone method is an efficient theoretical as well as numerical method to solve ordinary and fractional differential equations. The method relies heavily on the computation of coupled lower and upper solutions on a desired interval. In this work, we present a methodology to compute the coupled lower and upper solutions to scalar as well as two systems to any desired interval. Some numerical examples are also presented which demonstrates the application of the theoretical results. (Received August 21, 2012)

1083-34-169 **Paul Eloe*** (peloe1@udayton.edu). *A Leggett-Williams type theorem applied to a $2n$th order problem with symmetry.*

In this article we apply an extension of a Leggett-Williams type fixed point theorem to a two-point boundary value problem for a $2n$th order ordinary differential equation. The fixed point theorem employs concave and convex functionals defined on a cone in a Banach space. Inequalities that extend the notion of concavity to $2n$th order differential inequalities are derived and employed to provide the necessary estimates. Symmetry is employed in the construction of the appropriate Banach space. (Received August 27, 2012)

1083-34-210 **Bo Yang*** (byang@kennesaw.edu), Department of Mathematics and Statistics, Kennesaw State University, 1000 Chastain Road, #1601, Kennesaw, GA 30144. *An upper estimate for positive solutions of the $(p, n-p)$ conjugate boundary value problem.*

We consider the $(p, n-p)$ conjugate boundary value problem and prove a new upper estimate for positive solutions of the problem. (Received August 29, 2012)

35 ► Partial differential equations

1083-35-20 **Yuan Lou*** (lou.8@osu.edu), 231 West 18th Ave, Columbus, OH 43210. *Persistence of a Single Phytoplankton Species in a Water Column.*

We investigate a nonlocal reaction-diffusion-advection equation which models the growth of a single phytoplankton species in a water column where the species depends solely on light for its metabolism. We study the combined effect of death rate, sinking or buoyant coefficient, water column depth, and vertical turbulent diffusion rate on the persistence of a single phytoplankton species. This is a joint work with Sze-Bi Hsu, National Tsing-Hua University. (Received July 08, 2012)

1083-35-32 **Yongli Song** (05143@tongji.edu.cn), Department of Mathematics, Tongji University, Shanghai, 200092, Peoples Rep of China, and **Xingfu Zou*** (xzou@uwo.ca), Department of Applied Mathematics, University of Western Ontario, London, Ontario N6A 5B7, Canada. *Hopf bifurcation and Turing bifurcation in a ratio dependent predator-prey model with spatial diffusion and temporal delay.*

In this talk, I will present some results on a ratio dependent predator-prey model with spatial diffusion and temporal delay. By analysing the stability of a positive constant steady state, we found that both Hopf bifurcation and Turing bifurcation are possible within certain ranges of model parameters, with the latter leading to formation of spatial patterns. (Received July 26, 2012)

1083-35-33 **Robert Stephen Cantrell** and **Chris Cosner*** (gcc@math.miami.edu), Department of Mathematics, University of Miami, Coral Gables, FL 33124, and **Raul Manasevich**.
Global bifurcation of solutions for crime modeling equations.

We use global bifurcation theory to show pattern formation in a quasilinear system of two elliptic equations that has been developed by Short et al. [2] as a model for residential burglary. That model is based on the observation that the rate of burglaries of houses that have been burglarized recently and their close neighbors is typically higher than the average rate in the larger community, which creates patterns of "hotspots" for burglary. The analysis is based on recent results on global bifurcation in quasilinear elliptic systems derived by Shi and Wang [1]. We show in some cases that near the bifurcation point the bifurcating spatial patterns are stable.

[1]. J. Shi and X. Wang. On global bifurcation for quasilinear elliptic systems on bounded domains, Journal of Differential Equations, v.7 (2009), 2788-2812.

[2]. M.B. Short, M.R D'Orsogna, V.B. Pasour, G.E. Tita, P.J. Brantingham, A.L. Bertozzi and L.B. Chayes. A Statistical model of criminal behavior, Math Models and Methods in Applied Sciences, v.18 (2008), 1249-1267.

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1083-35-39 **Kaijun Zhang*** (zhangkj201@nenu.edu.cn), School of Mathematics and Statistics, Northeast Normal University, Changchun, Jilin 130024, Peoples Rep of China, **La-su Mai**, School of Mathematics and Statistics, Northeast Normal University, Changchun, Jilin 130024, Peoples Rep of China, and **Jingyu Li**, School of Mathematics and Statistics, Northeast Normal University, Changchun, Jilin 130024, Peoples Rep of China. .

We are concerned with the mathematical analysis of the relativistic Euler-Poisson equations in one dimensional case. The existence and uniqueness of the related smooth steady state solutions are proved. The non-relativistic limit and zero-relaxation limit of the model as well as their convergence rates are also obtained. (Received August 05, 2012)

1083-35-41 **Patricia Bauman*** (bauman@math.purdue.edu), 150 No. University Street, Dept. of Mathematics, West Lafayette, IN 47907, and **Jinhae Park** and **Daniel Phillips**. *Analysis of Defects in Nematic Liquid Crystals.* Preliminary report.

We investigate the structure of nematic liquid crystal thin films described by minimizers of the Landau-de Gennes energy in terms of a tensor-valued order parameter with Dirichlet boundary conditions of nonzero degree. We prove that as the elasticity constant goes to zero a limiting uniaxial texture forms with a finite number of defects, all of degree 1/2 or -1/2. We also analyze the location of defects and the limiting energy. (Received August 06, 2012)

1083-35-45 **Yuan Lou**, **Thomas Nagylaki** and **Linlin Su*** (lsu@wpi.edu), Department of Mathematical Sciences, Worcester Polytechnic Institute, Worcester, MA 01609. *An Integro-PDE Model From Population Genetics.*

We investigate an integro-partial differential equation that models the evolution of the frequencies for two alleles at a single locus under the joint action of migration, selection, and partial panmixia (i.e., global random mating). For arbitrary migration, we prove the uniqueness and global asymptotic stability of the nontrivial equilibrium. These results extent those for the classic cline problem (i.e., without panmixia). A major issue is to understand the effect of the rate of panmixia on the dynamics of the integro-PDE. Our results establish that increasing the rate of panmixia makes it harder to maintain the allele with the smaller average fitness in the population and increasing panmixia flattens the cline when the migration is conservative. (Received August 07, 2012)

1083-35-115 **YUNCHENG YOU*** (you@mail.usf.edu), Department of Mathematics and Statistics, University of South Florida, 4202 East Fowler Avenue, CMC 359, Tampa, FL 33620.
Random Attractors and Robustness for Stochastic Reaction-Diffusion Systems.

For a typical stochastic reversible autocatalytic reaction-diffusion system with multiplicative white noise on a three-dimensional bounded domain, the existence and the robustness of random attractors will be presented with relevant concepts and sharp uniform pullback estimates. (Received August 23, 2012)

1083-35-116 **Changfeng Gui** and **Mingfeng Zhao*** (mingfeng.zhao@uconn.edu), Department of Mathematics, 196 Auditorium Road, Unit 3009, Storrs, CT 06269-3009. *Traveling Wave Solutions of Allen-Cahn Equation with Fractional Laplacians.*

In this talk, I will discuss the existence, uniqueness, asymptotic behavior and other qualitative properties of traveling wave solutions to Allen-Cahn equation with fractional Laplacians where the double well potential has unequal depths. The existence is proved by using a continuity argument, where a key ingredient is the estimate of the speed of the traveling wave in terms of the potential in order to get the uniform estimates of the Holder norm. (Received August 24, 2012)

1083-35-122 **Xinfu Chen** and **King-Yeung Lam***, lam.184@osu.edu, and **Yuan Lou**. *Faster vs Slower Diffuser.*

We study the dynamics of a reaction-diffusion-advection model for two competing species in a spatially heterogeneous environment. Primary interest is in the outcome of the competition between two species which are assumed to have the same population dynamics but different dispersal strategies: both species diffuses by a combination of random diffusion and advection along the environmental gradient, but with different diffusion and/or advection rates. We show that when the advection rates are large, then the faster diffuser wins the competition, this is in contrast to the previously known result that the slower diffuser prevails when there is small or no advection in [Dockery et. al, JMB (1998)]. (Received August 24, 2012)

1083-35-127 **Justin C Tzou***, tzou.justin@gmail.com, and **Yi-Ping Ma**, **Alvin Bayliss**, **Bernard J Matkowsky** and **Vladimir A Volpert**. *Homoclinic Snaking Near a Codimension Two Turing-Hopf Bifurcation Point in the Brusselator Model.* Preliminary report.

Spatiotemporal Turing-Hopf pinning solutions near the codimension two Turing-Hopf point of the one dimensional Brusselator model are studied. Both the Turing and Hopf bifurcations are supercritical and stable. The pinning solutions exhibit coexistence of stationary stripes of near critical wavelength and time periodic oscillations near the characteristic Hopf frequency. The solution branches are organized in a series of saddle-node bifurcations similar to snaking structures of stationary pinning solutions. We find two intertwined pairs of such branches, one with a defect in the middle of the striped region, and one without. These branches are connected to branches exhibiting collapsed snaking behavior. Time dependent depinning dynamics outside the saddle-nodes are illustrated, and a time scale for the depinning transitions is numerically established. Wavelength variation within the snaking region is discussed, and reasons for the variation are given in the context of amplitude equations. The pinning region is compared favorably to the Maxwell line found numerically by time evolving the amplitude equations. (Received August 24, 2012)

1083-35-129 **Hiroko Yamamoto***, Mathematical Institute, Tohoku University, Aoba, Aoba-ku, Sendai, Miyagi 980-8578, Japan, and **Izumi Takagi**. *Effect of the heterogeneity on the concentration point in the ground-state solution of a reaction-diffusion equation.* Preliminary report.

In a bounded domain in the n dimensional Euclidian space, we consider positive solutions of the semilinear elliptic equation

$$\varepsilon^2 \Delta u - a(x)u + b(x)u^p + \delta\sigma(x) = 0$$

under homogeneous Neumann boundary conditions. Here, $a(x)$, $b(x)$ are positive, and $\sigma(x)$ is nonnegative; $\varepsilon > 0$, $\delta \geq 0$ are constants. This problem appears in the stationary problem for the shadow system of the activator-inhibitor model proposed by Gierer and Meinhardt.

The mountain pass lemma gives us a ground-state solution. For sufficiently small ε the ground-state solution concentrates around a single point P_0. In this talk, under some conditions on p, we describe the procedure to locate P_0 in terms of $a(x)$, $b(x)$ and $\sigma(x)$. We discuss how to find the concentration point for δ sufficiently small from that of the case $\delta = 0$. It is to be noted that P_0 may be in the interior of or on the boundary of the domain, depending on the distribution of $a(x)$, $b(x)$ and $\sigma(x)$. (Received August 25, 2012)

1083-35-146 **Nicholas M. Ercolani*** (ercolani@math.arizona.edu). *A Burgers Model for Striped Pattern Formation in the Strong Bending Regime.*

We will present a model for the formation of defects in patterns that arise in 2D, spatially extended physical systems whose principal bifurcation is from spatial homogeneity to semi-discrete ("striped") patterns. Our model stems from a variational extension of the Cross-Newell phase diffusion equation and incorporates perspectives from experiment (Rayleigh-Benard convection), simulation and analysis. While past work on this model has emphasized negative results, this talk will explore methods aimed at ascertaining the actual structure of minimizers.

The analysis takes advantage of a Cole-Hopf linearization for the variational equations and invites comparison to the known validity of the Burgers phase equation in 1D. (Received August 26, 2012)

1083-35-163 **Donna S Stutson*** (dstutson@xula.edu), Xavier University of Louisiana, 1 Drexel Dr., New Orleans, LA 70125, and **A. S. Vatsala**. *A Representative Formula for the One Dimensional Caputo Fractional Reaction Diffusion Equation and a numerical example using the Generalized Monotone Method.*

Here we will look at a representative formula for the one dimensional Caputo Fractional Reaction Diffusion Equation

$$\begin{aligned} {}^c\partial_t^q u - k\frac{\partial^2 u}{\partial x^2} &= f(t,x,u) + g(t,x,u) \quad (t,x) \in Q_T \\ u(t,0) = A(t), \quad u(t,L) &= B(t) \quad (t,x) \in \Gamma_T \\ u(0,x) &= h(x) \qquad x \in \overline{\Omega} \end{aligned}$$

where $\Omega = [0, L]$, $J = (0, T]$, $Q_T = J \times \Omega$, $k, > 0$ and $\Gamma_T = (0, T) \times \partial\Omega$. ${}^c\partial_t^q u$ is the Caputo Partial Derivative with respect to t of order q, $0 < q < 1$. A Numerical example is provided using the generalized monotone method. (Received August 27, 2012)

1083-35-181 **Izumi Takagi*** (takagi@m.tohoku.ac.jp), Mathematical Institute, Tohoku University, Aoba, Aoba-ku, Sendai, Miyagi 980-8578, Japan. *Movement of a solution having a single spike on the boundary of a semilinear parabolic equation.* Preliminary report.

We consider the initial value problem for a semilinear parabolic equation with subcritical growth rate under the homogeneous Neumann boundary condition. Bates, Lu and Zeng proved that this problem has a normally hyperbolic invariant manifold consisting of functions which have a single boundary spike. This means that if we take an initial function belonging to the invariant manifold, then the solution exists for all time and the behavior of the solution is determined by that of the (spatial) maximum point which moves on the boundary. They showed that, as a principal approximation, the maximum point moves along the gradient flow of the mean curvature function. In this talk we describe the procedure for computing the coefficients of the asymptotic expansion with respect to the diffusion constant of the kinetic equation for the maximum point, in order to know the behavior of solutions near the critical point of the curvature function. The result is obtained as the joint work with Masaaki Kudo. (Received August 27, 2012)

1083-35-199 **Shu Dai**, **Dong Li** and **Kun Zhao*** (kzhao@tulane.edu). *Non-existence result for a class of Shigesada-Kawasaki-Teramoto type reaction-cross diffusion models.*

We consider a class of Shigesada-Kawasaki-Teramoto type reaction-cross diffusion models with vanishing random diffusion coefficients. For homogeneous Dirichlet boundary conditions we prove non-existence of global-in-time non-trivial non-negative smooth solutions. Some numerical results are also presented, suggesting the possibility of finite time extinction. (Received August 27, 2012)

1083-35-203 **Masaharu Taniguchi*** (masaharu.taniguchi@is.titech.ac.jp), Dept of Mathematical and Computing Sciences, Tokyo Institute of Technology, 2-12-1-W8-38 Ookayama, Meguro-ku, Tokyo, 152-8552, Japan. *Multi-dimensional traveling fronts in bistable reaction-diffusion equations in $\mathbb{R}^N$.*

This paper studies traveling fronts of cylindrically non-symmetric shapes in bistable reaction-diffusion equations in $\mathbb{R}^N$ for $N \geq 3$.

Cylindrically symmetric traveling fronts have been studied by Hamel, Monneau and Roquejoffre (2005, 2006). For $N = 3$ cylindrically non-symmetric traveling fronts are studied by myself (2012).

For $N \geq 3$ we construct cylindrically non-symmetric traveling fronts for any given $g \in C^2(S^{N-1})$. (Received August 28, 2012)

37 ► Dynamical systems and ergodic theory

1083-37-108 **Liang Kong***, 221 Parker Hall, Department of Mathematics, Auburn, AL 36849, and **Wenxian Shen**, Auburn University. *Positive Stationary Solutions and Spreading Speeds of KPP Equations in Locally Spatially Inhomogeneous Media.*

This paper mainly explores spatial spread and front propagation dynamics of KPP evolution equations with random or nonlocal or discrete dispersal in unbounded inhomogeneous and random media and reveals such an important biological scenario: the localized spatial in-homogeneity of the media does not prevent the population

to persist and to spread, moreover, it neither slows down nor speeds up the spatial spread of the population. (Received August 23, 2012)

41 ► Approximations and expansions

1083-41-6 **Simon Foucart** and **Tatyana Sorokina***, tsorokina@towson.edu. *Computation of dimensions of multivariate spline spaces via Hilbert polynomials and Hilbert series.* Preliminary report.

A computational method to obtain explicit formulae for the dimension of spline spaces of smoothness r and degree d over simplicial partitions is described. We show how to derive these formulae in the form of a linear combination of binomial coefficients using computed values of this dimension for a finite number of parameters r and d to interpolate the Hilbert polynomial. Then we apply Hilbert series to obtain explicit formulae. The method is applied to conjecture the dimension formulae for the Alfeld split of an n-simplex and for several other tetrahedral partitions. (Received April 10, 2012)

1083-41-87 **Jan Minac** (minac@uwo.ca), Department of Mathematics, The University of Western Ontario, London, Ontario N6A 5B7, Canada, and **Stefan O Tohaneanu*** (stohanea@uwo.ca), Department of Mathematics, The University of Western Ontario, London, Ontario N6A 5B7, Canada. *From Splines Approximation to Roth's Equation and Schur Functors.*

Alfeld and Schumaker provide a formula for the dimension of the space of piecewise polynomial functions, called splines, of degree d and smoothness r on a generic triangulation of a topological disk, for $d \geq 3r+1$. Schenck and Stiller conjectured that this formula actually holds for all $d \geq 2r+1$. Up to this moment there was not known a single example where one could show that the bound $d \geq 2r+1$ is sharp. However, in 2005, a possible such example was constructed to show that this bound is the best possible (i.e., the Alfeld-Schumaker formula does not hold if $d = 2r$, for any r), except that the proof that this formula actually works if $d \geq 2r+1$ has been a challenge up to this time when we finally show to be true. The interesting subtle connections with representation theory, matrix theory and commutative and homological algebra seem to explain why this example presented such a challenge. One needs to mention that this conjecture in fact generalizes the famous $3-1$ conjecture, which says that the formula of Alfeld and Schumaker is true for any triangulation of a planar topological disk, where $d = 3$ and $r = 1$. (Received August 21, 2012)

1083-41-125 **boris shekhtman***, department of mathematics, USF, Tampa, FL 33620. *What Ideal Projectors are limits of Lagrange Projectors.*

The title of this abstract is a question asked by Carl de Boor several years ago. The question is equivalent to the question: what classes of ideals belong to the good component of the Hilbert scheme. In my talk I will outline some known classes of ideal projector that are and are not the limits of Lagrange ones. I will also entertain some conjectures regarding the question. (Received August 24, 2012)

46 ► Functional analysis

1083-46-168 **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 real KC*-algebras.*

We introduce real KC*-algebras as Banach-Kantorovich spaces which are at the same time real symmetric *-algebra with sub-multiplicative and C*-regular vector norms. Among other results we show that a decent of the real C*-algebra in a Boolean-valued universe is a real KC*-algebra. Inversely, we show that for each real KC*-algebra A there exists a Boolean-valued universe and an object in it such that its decent is real algebraically *-isomorphic and isometric to A. (Received August 28, 2012)

47 ► Operator theory

1083-47-70 **Abdelhamid Benmezai** and **John R. Graef*** (john-graef@utc.edu), Department of Mathematics, University of Tennessee at Chattanooga, Chattanooga, TN 37403, and **Lingju Kong**. *Existence of positive solutions to an abstract Hammerstein equation.*

Fixed point index properties are used to prove existence of positive solutions to the abstract Hammerstein equation $u = LFu$ where $L : E \to E$ is a compact linear operator, $F : K \to K$ is a continuous and bounded mapping, E is a Banach space, and K is a cone in E. The results are then applied to obtained existence results for positive solutions of two point boundary value problems for differential equations. (Received August 16, 2012)

52 ► Convex and discrete geometry

1083-52-128 **June Huh*** (junehuh@umich.edu), 512 Walnut St. #11, Ann Arbor, MI 48104. *h-Vectors of matroids and logarithmic concavity.*

Let M be a matroid on E, representable over a field of characteristic zero. We show that h-vectors of the following simplicial complexes are log-concave:

(1) The matroid complex of independent subsets of E.

(2) The broken circuit complex of M relative to an ordering of E.

The first implies a conjecture of Colbourn on the reliability polynomial of a graph, and the second implies a conjecture of Hoggar on the chromatic polynomial of a graph. The proof is based on the geometric formula for the characteristic polynomial of Denham, Garrousian, and Schulze. (Received August 24, 2012)

53 ► Differential geometry

1083-53-17 **Gianluca Bande**, Dipartimento di Matematica e Informatica, Università degli studi di Cagliari, Via Ospedale 72, 09124 Cagliari, Italy, **David E. Blair*** (blair@math.msu.edu), Department of Mathematics, Michigan State University, East Lansing, MI 48824, and **Amine Hadjar**, Laboratoire de Mathématiques, Informatiqu, Université de Haute Alsace-4, Rue de Fréres Lumiére, 68093 Mulhouse, France. *Curvature of contact metric manifolds and metric contact pairs (bicontact manifolds).*

We begin with a general survey of contact geometry from the Riemannian point of view including a number of curvature properties.

Then we discuss the idea of a contact pair, Reeb vector fields, characteristic foliations and metric contact pairs (MCPs). A 6-dimensional example with orthogonal characteristic foliations which is not a locally Riemannian product manifold will be presented.

Turning to joint work on MCPs, basic properties of the curvature tensor and the Ricci curvature in the direction of the sum of the two Reeb vector fields will be given. This leads to the result that flat non-Kähler Vaisman manifolds do not exist. A local classification of MCPs whose curvature vanishes on the vertical subbundle will be given. As a corollary flat associated metrics only exist if the leaves of the characteristic foliations are at most three-dimensional.

Turning to symmetry we prove that the universal covering of a complete locally symmetric normal MCP is a Calabi-Eckmann manifold. Moreover a complete, simply connected, normal MCP with regular vertical foliation such that reflections in the leaves are isometries, is the product of globally ϕ-symmetric spaces and fibers over a locally symmetric space endowed with a symplectic pair. (Received August 03, 2012)

1083-53-18 **Kyung-Bai Lee** (kblee@math.ou.edu), Department of Mathematics, University of Oklahoma, Norman, OK 73019, and **Scott Van Thuong*** (sthuong@math.ou.edu), Department of Mathematics, University of Oklahoma, Norman, OK 73019. *Sol_1^4-geometry.*

The purpose of this paper is to classify all compact manifolds modeled on the 4-dimensional solvable Lie group Sol_1^4. The maximal compact subgroup of $\mathrm{Isom}(\mathrm{Sol}_1^4)$ is $D_4 = \mathbb{Z}_4 \rtimes \mathbb{Z}_2$. We shall exhibit an infrasolv-manifold with Sol_1^4-geometry whose holonomy is D_4. This implies that all possible holonomy groups do occur; $\{1\}$, $\mathbb{Z}_2$ (3 non-isomorphic ones), $\mathbb{Z}_4$ (all non-orientable), $\mathbb{Z}_2 \times \mathbb{Z}_2$ and $\mathbb{Z}_4 \rtimes \mathbb{Z}_2$. Finally we will determine the unoriented cobordism classes of these manifolds. (Received July 03, 2012)

1083-53-133 **Charles P Boyer*** (cboyer@math.unm.edu), Department of Mathematics and Statistics, Science and Mathematics Learning Center, Albuquerque, NM 87107. *Contact Structures of Sasaki type on S^3-bundles over Riemann Surfaces.* Preliminary report.

My talk is based on joint ongoing work with Christina Tønnesen-Friedman. I begin the talk by giving a brief general discussion about contact structures of Sasaki type. Sasakian structures within such contacts structures occur in bouquets of Sasaki cones. The cones arise from maximal tori in the Sasakian automorphism group, whereas, different cones in a bouquet correspond to distinct conjugacy classes of tori (sometimes maximal) in the contactomorphism group. A fairly explicit description is given in the case of S^3-bundles over Riemann surfaces of arbitrary genus g. In this case the work of Buşe on equivariant Gromov-Witten invariants is used to distinguish the conjugacy classes of tori. We are also interested in determining the space of extremal Sasakian structures within a fixed isotopy class of contact structures, and in particular those of constant scalar curvature. (Received August 25, 2012)

1083-53-196 **Peter Lambert-Cole*** (plambe7@lsu.edu). *New examples of Legendrian submanifolds in higher dimensions.*

Contact geometry in higher dimensions (≥ 5) is not well understood but is attracting increasing attention. This talk will explore higher dimensional contact manifolds by constructing a wealth of examples of Legendrian submanifolds. I will describe a construction that takes two Legendrians, $L \subset P \times \mathbb{R}$ and $K \subset Q \times \mathbb{R}$, and gives a Legendrian submanifold $L \times K \subset P \times Q \times \mathbb{R}$. Surprisingly, this simple construction yields many interesting examples because it depends upon the explicit embeddings of L, K and not their Legendrian isotopy classes. The proof relies on a formula for the Thurston-Bennequin invariant of the product Legendrian. This construction demonstrates that contact geometry in higher dimensions is extremely rich. (Received August 27, 2012)

1083-53-208 **John B Etnyre**, **Rafal Komendarczyk*** (rako@tulane.edu) and **Patrick Massot**. *Quantitative Darboux theorems in contact geometry.*

I will describe various forms of useful compatibility between the contact structures and Riemannian metrics. Then sketch how to obtain a lower bound for the radius of a geodesic ball in a contact $(2n+1)$–manifold that can be embedded in the standard contact structure on $\mathbb{R}^{2n+1}$, that is on the size of a Darboux ball. The bound is derived in a compatible Riemannian metric. (Received August 28, 2012)

54 ► General topology

1083-54-90 **Iván Martínez-Ruiz*** (imartinez@fcfm.buap.mx), Calle 4 B 13, Bosques de San Sebastian, 72310 Puebla, Mexico. *Weak selections and Tournaments.*

Let X be a nonempty set. A weak selection for X is a function $\varphi : X \times X \to X$ that satisfies the following properties for any $x, y \in X$:
(a) $\varphi(x, y) = \varphi(y, x)$,
(b) $\varphi(x, y) \in \{x, y\}$.

If X is a topological space, we say that φ is a continuous weak selection if it is continuous with respect to the product topology. If we restrict our attention to the collection of pairs $(x, y) \in X \times X$, with $x \neq y$, we can naturally define a tournament $G = (X, V)$, where $(x, y) \in V$ whenever $\varphi(x, y) = x$ and, equivalently, it is possible to define a relation $<_\varphi$ on $X \times X$ by $x <_\varphi y$ if $\varphi(x, y) = x$. On the other hand, it is possible to realize a study of weak selections from another point of view. Starting from a weak selection φ on a given set X, we consider the topology generated by the relation $<_\varphi$.

The main idea of this talk is to present some of the applications of directed graphs and tournaments in the study of weak selections and topological properties of spaces. (Received August 21, 2012)

55 ► Algebraic topology

1083-55-59 **Nicholas A Scoville*** (nscoville@ursinus.edu), 610 E. Main Street, Dept. of Math and CS, Collegeville, PA 19426. *Discrete Lusternik–Schnirelmann category.* Preliminary report.

The discrete version of Morse theory due to Robin Forman is a powerful tool utilized in the study of topology, combinatorics, and mathematics involving the overlap of these fields. Inspired by the success of discrete Morse theory, we develop a discrete version of the Lusternik–Schnirelmann category suitable for cell complexes. This invariant is based on collapsibility as opposed to contractibility. We will show where it agrees and differs from

that of the smooth case. We discuss a theorem which relates our discrete version of the Lusternik–Schnirelmann category to Forman's discrete Morse theory. (Received August 14, 2012)

1083-55-75 **Jozef H. Przytycki*** (przytyck@gwu.edu), Department of Mathematics, George Washington University, Washington, DC 20052. *Extending an entropic magma by an affine entropic magma.*

It is a classical result in group theory that extensions of a group G by an abelian group A, with the given action of G on A are classified by $H^2(G, A)$. The analogous result for racks and quandles was obtained by Carter-Elhamdadi-Kamada-Saito. Here we consider the case of entropic magma $(X; *)$ (that is $(a*b)*(c*d) = (a*c)*(b*d)$). To build an entropic operation on $A \times X$ we assume that A is an affine entropic magma, that is A is an abelian group with two commuting automorphisms, t, s (equivalently, A is a $Z[t^{\pm 1}, s^{\pm 1}]$-module) and the operation is given by $a_1 * a_2 = ta_1 + sa_2 + a_0$. The action on $A \times X$is given by $(a_1, x_1)*(a_2, x_2) = (a_1 * a_2 + f(x_1, x_2), x_1 * x_2)$. We show that the action is entropic if $tf(x_1, x_2) - tf(x_1, x_3) + sf(x_3, x_4) - sf(x_2, x_4) + f(x_1 * x_2, x_3 * x_4) - f(x_1 * x_3, x_2 * x_4) = 0$ (2-cocycle condition). Two operations on $A \times X$ yielded by f_1 and f_2 are (fiber preserving) equivalent if $f_1 - f_2 = \partial c$ where $c : X \to A$ and$(\partial c)(x_1, x_2) = tc(x_1) + sc(x_2) - c(x_1 * x_2)$. This is the starting point of our work with Maciej Niebrzydowski were we construct homology theory for entropic magmas and look forgeneralization of Conway algebra invariants of links developed by Przytycki-Traczyk. (Received August 17, 2012)

1083-55-167 **Xuanting Cai** and **Robert Todd*** (rtodd@unomaha.edu). *Some properties and applications of a graph basis for the Temperley–Lieb algebra.* Preliminary report.

We will review the definition of a basis for the Temperley-Lieb algebra originally proposed by Lickorish. Some properties of this basis will be explored and an application to the Mahler measure of the recursively defined elements of the Temperley-Lieb algebra will discussed. (Received August 27, 2012)

57 ► Manifolds and cell complexes

1083-57-3 **Lenhard L. Ng*** (ng@math.duke.edu), Mathematics Department, Duke University, box 90320, Durham, NC 27708. *From holomorphic curves to knot invariants via the cotangent bundle.*

In recent years, symplectic geometry has emerged as a key tool in the study of low-dimensional topology. One approach is to study the topology of a smooth manifold through the symplectic geometry of its cotangent bundle, building on the familiar concept of "phase space" from classical mechanics.

We will focus on a particular application of this philosophy, which uses certain counts of holomorphic curves to produce an invariant of knots called "knot contact homology". Knot contact homology has a combinatorial definition and appears to be a very strong knot invariant. Recently it has been linked to other known invariants such as the HOMFLY-PT polynomial, via a deep connection to string theory and mirror symmetry that we are just barely beginning to understand. We will introduce knot contact homology, discuss its properties and some applications, and speculate about the meaning of its appearance in string theory. No previous familiarity with symplectic geometry or knot theory is assumed. (Received August 22, 2012)

1083-57-8 **Moshe Cohen*** (cohenm10@macs.biu.ac.il), Bar-Ilan University, Department of Mathematics, 52900 Ramat Gan, Israel, and **Mina Teicher**. *Computing the height of Kauffmam's clock lattice.* Preliminary report.

We give an algorithmic computation for the height of Kauffman's clock lattice obtained from a knot diagram with two adjacent regions starred and without crossing information specified.

Abe defines the clock number p(K) of a knot K to be the minimum over all diagrams of the height of the clock lattice obtained from a knot diagram. We show that this lattice is more familiarly the graph of perfect matchings of a bipartite graph Γ obtained from the knot diagram by overlaying the Tait graph G of the knot and its dual G*.

We obtain upper bounds for the clock number p(K) of the knot from the combinatorics of Γ. (Received May 15, 2012)

1083-57-14 **Morwen Thistlethwaite** and **Anastasiia Tsvietkova*** (tsvietkova@math.utk.edu). *Hyperbolic structures from link diagrams.* Preliminary report.

W. Thurston demonstrated that every link in S^3 is a torus link, a satellite link or a hyperbolic link and these three categories are mutually exclusive. It also follows from work of W. Menasco that an alternating link represented by a prime diagram is either hyperbolic or a $(2, n)$–torus link. The talk will introduce an alternative

method for computing the hyperbolic structure of the complement of a hyperbolic link. It allows computing the structure directly from the link diagram. Some of its consequences will be discussed, including a surprising rigidity property of certain tangles, and the formulas that allow one to calculate the exact hyperbolic volume, as well as complex volume, of hyperbolic 2–bridge links. (Received July 01, 2012)

1083-57-28 **J Etnyre*** (etnyre@math.gatech.edu), **R Komendarczyk** and **P Massot**. *Contact geometry and Riemannian metrics: a contact version of the sphere theorem.*

Since the work of Chern and Hamilton there has been a great deal of work studying Riemannian metrics adapted to contact structures, but most of this work has focused on properties of the Riemannian metric. There have been few results concerning properties of the contact structure in terms of the Riemannian metric. This talk can be viewed of a continuation of Komendarczyk's talk, where he discuss a "quantitative Darboux theorem". Building on this work I will discuss a "contact sphere theorem": if you have a contact 3-manifold and a metric adapted to it with positive 4/9-pinched curvature then the manifold is the sphere and the contact structure is standard. (Received July 22, 2012)

1083-57-54 **Moshe Cohen** and **Adam M Lowrance***, 124 Raymond Ave., Box 257, Poughkeeepsie, NY 12604. *A categorification of the Tutte polynomial.*

We construct a triply graded homology theory that categorifies the Tutte polynomial of a graph or matroid. We discuss generalizations of the deletion-contraction and duality formulas for the Tutte polynomial. We also discuss relationships to other categorifications of the Tutte polynomial. (Received August 13, 2012)

1083-57-64 **Charles D Frohman*** (charles-frohman@uiowa.edu), Department of Mathematics, The University of Iowa, Iowa City, IA 52245. *A Geometric Approach to the Jones Polynomial.* Preliminary report.

We will outline a geometric construction of a module over the exponentiated Weyl Algebra corresponding to peripheral skein module of a knot complement and discuss the structure of it's annihilator. (Received August 15, 2012)

1083-57-66 **Daniel S Silver*** (silver@southalabama.edu), Dept Math and Stat, ILB 325, Mobile, AL 36688, **Susan G Williams** (swilliam@southalabama.edu), Dept Math and Stat, ILB 325, Mobile, AL 36688, and **J Scott Carter** (carter@southalabama.edu), Dept Math and Stat, ILB 325, Mobile, AL 36688. *Invariants of Links in Thickened Surfaces.* Preliminary report.

A group invariant G of an oriented link in a thickened closed orientable surface S is defined. The invariant is a finitely presented operator group in the sense of Krull and Noether. Polynomial invariants are defined. Applications to virtual links are described. In particular, lower bounds for virtual genus and obstructions to invertibility are found. (Received August 16, 2012)

1083-57-67 **David T Gay*** (dgay@uga.edu), Department of Mathematics, University of Georgia, Athens, GA 30602, and **Robion Kirby**, Department of Mathematics, University of California, Berkeley, CA 94720-3840. *Existence and uniqueness for trisections of 4-manifolds.*

A trisection of a 4–manifold is a decomposition into 3 pieces, each diffeomorphic to the boundary connected sum of k copies of $S^1 \times B^3$, for some k. The pairwise intersections are handlebodies of some genus g and the triple intersection is a surface of genus g. This is an analog of a Heegaard splitting of a 3–manifold, but to go up in dimension we need more pieces. I will present the existence and uniqueness theorem, discuss it's proof, and conjecture about applications. (Received August 16, 2012)

1083-57-68 **Abhijit Champanerkar*** (abhijit@math.csi.cuny.edu), Department of Mathematics, College of Staten Island CUNY, 2800 Victory Boulevard, Staten Island, NY 10314, and **Philip Ording** (pording@mec.cuny.edu), Department of Mathematics, Medgar Evers College CUNY, 1650 Bedford Ave, Brooklyn, NY 11225. *Quasi-alternating Montesinos links.*

Quasi-alternating links are a generalization of alternating links. They are homologically thin for both Khovanov homology and knot Floer homology. In this talk we will discuss the quasi-alternating classification for Montesinos links. (Received August 16, 2012)

1083-57-88 **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)

1083-57-101 **David Futer**, **Efstratia Kalfagianni** and **Jessica S Purcell*** (jpurcell@math.byu.edu). *Quasifuchsian surfaces in knot complements.*

When a knot or link diagram admits certain combinatorial properties, there will always be an embedded essential surface in the corresponding link complement. This surface is called a state surface, for an appropriate Kauffman state. By work of Bonahon and Thurston, every embedded essential surface in a hyperbolic 3-manifold is exactly one of accidental, a (semi) fiber, or quasifuchsian. We show that the essential state surface will never be accidental. It will be a fiber if and only if the diagram satisfies a simple combinatorial property, and otherwise quasifuchsian. In several instances, we show that the geometric type of the surfaces is completely determined by certain coefficients of the colored Jones polynomial. This is joint work with David Futer and Efstratia Kalfagianni. (Received August 22, 2012)

1083-57-105 **David Futer*** (dfuter@temple.edu), **Efstratia Kalfagianni** (kalfagia@math.msu.edu) and **Jessica S Purcell** (jpurcell@math.byu.edu). *The Jones polynomial and surfaces far from fibers.*

Under mild conditions on a knot diagram $D(K)$, we show that certain coefficients of the Jones and colored Jones polynomials measure the "non-fiberness" of a spanning surface for the knot. As a consequence, these coefficients give estimates on the hyperbolic volume of the knot complement. This is joint work with Effie Kalfagianni and Jessica Purcell. (Received August 23, 2012)

1083-57-110 **Ilya Kofman***, ikofman@math.csi.cuny.edu, and **Joan Birman**, jb@math.columbia.edu. *Lorenz and horseshoe knots.* Preliminary report.

The Lorenz flow is the prototypical chaotic dynamical system with a "strange attractor". Lorenz knots are periodic orbits in the Lorenz flow on R^3. Horseshoe knots are periodic orbits in the flow on R^3 given by the suspension of Smale's horseshoe map. In this talk, I will provide some background, and discuss some surprising relationships between these knots and the simplest hyperbolic knots. (Received August 23, 2012)

1083-57-123 **Patrick M Gilmer*** (gilmer@math.lsu.edu) and **Gregor Masbaum**. *Irreducible factors of modular representations of mapping class groups arising in Integral TQFT.*

We find decomposition series of length at most two for modular representations in positive characteristic of mapping class groups of surfaces induced by an integral version of the Witten-Reshetikhin-Turaev SO(3)-TQFT at the p-th root of unity, where p is an odd prime. The dimensions of the irreducible factors are given by Verlinde-type formulas. (Received August 24, 2012)

1083-57-142 **Amey Kaloti*** (ameyk@math.gatech.edu), 686 Cherry St NW, School of Mathematics, Georgia Institute of Technology, Atlanta, GA 30332. *Stein fillings of planar open books.*

Classification of stein fillings of contact 3-manifolds is an active area of research. Building on the work of Wendl on planar open books, we will classify stein fillings of virtually overtwisted contact structure on lens spaces $L(p(n+1)+1, n+1)$ for $p \geq 1, n \geq 0$. If time permits we will also talk about geography problem of stein fillings for contact structures supported by planar open books. (Received August 26, 2012)

1083-57-150 **Kate Petersen*** (petersen@math.fsu.edu). *Character Varieties of Families of One-Cusped Hyperbolic 3-Manifolds.*

I will discuss geometric properties of character varieties of certain families of one-cusped hyperbolic 3-manifolds. In particular, I will concentrate on how properties, like the genus, differ in these families. (Received August 26, 2012)

1083-57-154 **Lenhard Ng** and **Dan Rutherford*** (drruther@uark.edu). *Satellites of Legendrian knots and representations of the Chekanov-Eliashberg algebra.*

The Chekanov-Eliashberg differential graded algebra (DGA) is an invariant of Legendrian knots in standard contact $\mathbb{R}^3$ that is a particular instance of Legendrian contact homology. There is a well-known correspondence (due to Fuchs-Ishkanov and Sabloff) between augmentations of the Chekanov-Eliashberg DGA and normal rulings of the front projection of L. We generalize this to a correspondence between finite-dimensional representations of the DGA and certain normal rulings of satellites of L and derive several consequences. In particular, the existence of ungraded representations of any given dimension depends only on the Thurston-Bennequin number and underlying smooth knot type of L. (Received August 26, 2012)

1083-57-162 **Samuel Lisi**, , Belgium, **Jeremy Van Horn-Morris*** (jvanhorn@math.stanford.edu), Department of Mathematics, SCEN 301, 1 University of Arkansas, Fayetteville, CA 72701, and **Chris Wendl**. *Spinal open books and symplectic fillings.*

A spinal open book decomposition on a contact manifold is a generalization of a supporting open book, which, for example, exists naturally on the boundary of a symplectic filling with a Lefschetz fibration over any compact oriented surface with boundary. We show that whenever a contact 3-manifold admits such a decomposition with a planarity assumption, its symplectic fillings can be classified in terms of diffeomorphism classes of Lefschetz fibrations. As an example, we characterize precisely which circle bundles with S^1-invariant contact structures are strongly fillable, and show that the fillable ones always have a unique filling. (Received August 27, 2012)

1083-57-179 **Christopher R Cornwell*** (cornwell@math.duke.edu). *Augmentations and knot contact homology.*

Knot contact homology is an invariant of knots, found as the homology of a differential graded algebra (DGA) that counts holomorphic curves in the cotangent bundle of $\mathbb{R}^3$ with Lagrangian boundary on the conormal bundle to the knot. The augmentation polynomial, whose zero locus determines the image of the base ring under augmentations of the DGA, while weaker than the DGA, appears to contain a wealth of information. For example, the augmentation polynomial detects the unknot and has (a specialization with) the A-polynomial as a factor. It is also conjectured to determine the colored HOMFLY polynomials. We will discuss a view of augmentations through representation theory of the knot group, applying this to the augmentation polynomial of torus knots. (Received August 27, 2012)

1083-57-180 **Neal W Stoltzfus*** (stoltz@math.lsu.edu), Dept. Math., Louisiana State Univ., Baton Rouge, LA 70803, and **Jordan Keller** and **MurphyKate Montee**. *Recursive Behavior of Ribbon Graph Polynomials and applications to link polynomials.* Preliminary report.

The transfer method of generating functions is applied to the ribbon graph rank polynomial $R(\mathbb{D}; X, Y, Z)$ (due to Bollobás, Riordan, Whitney and Tutte) of a sequence of ribbon graphs, $\mathbb{D}_n$ constructed by successive amalgamation with a fixed pattern ribbon graph. By the transfer method this sequence of rank polynomials is shown to be recursive: that is, polynomials $R(\mathbb{D}_n; X, Y, Z)$ satisfy a linear recurrence relation with coefficients in $\mathbb{Z}[X, Y, Z]$.

Applying the work of Dasbach et al. showing that the Jones polynomial is a specialization of the ribbon graph rank polynomial, we apply this method to the Jones polynomials of certain families of links. (Received August 27, 2012)

1083-57-182 **Gordana Matic*** (gordana@math.uga.edu), Department of Mathematics, University of Georgia, Athens, GA 30605. *Heegaard-Floer type invariants of contact structures.*

I will give an introduction to invariants of contact structures in Heegaard Floer and Sutured Floer homology, and talk about their applications to questions of tightness and fillability. (Received August 27, 2012)

1083-57-189 **Susan Abernathy***, sabern1@tigers.lsu.edu. *On Krebes' tangle.*

A genus-1 tangle $\mathcal{G}$ is an arc properly embedded in a standardly embedded solid torus S in the 3-sphere. We say that a genus-1 tangle embeds in a knot $K \subseteq S^3$ if the tangle can be completed by adding an arc exterior to the solid torus to form the knot K. We call K a closure of $\mathcal{G}$. An obstruction to embedding a genus-1 tangle $\mathcal{G}$ in a knot is given by torsion in the homology of branched covers of S branched over $\mathcal{G}$. We examine a particular example $\mathcal{A}$ of a genus-1 tangle, given by Krebes, and consider its two double-branched covers. Using this homological obstruction, we show that any closure of $\mathcal{A}$ obtained via an arc which passes through the hole of S an odd number of times must have determinant divisible by three. A resulting corollary is that if $\mathcal{A}$ embeds in the unknot, then the arc which completes $\mathcal{A}$ to the unknot must pass through the hole of S an even number of times. (Received August 27, 2012)

1083-57-190 **Cody W. Armond*** (cody-armond@uiowa.edu) and **Oliver T. Dasbach**. *The head and tail of the colored Jones polynomial for adequate links.* Preliminary report.

It has been shown that the colored Jones polynomial of alternating links has a well-defined head and tail, which are power series coming from the sequence of leading and ending coefficients.

We will discuss how the head and tail of adequate links can be seen as a product of heads and tails of alternating links. We will also discuss a second product structure on heads and tails and how the two are related. (Received August 27, 2012)

1083-57-191 **M Kate Kearney*** (kearney@lsu.edu). *Concordance Genus of 11–crossing Knots.*

The concordance genus of a knot is the least genus of any knot in its concordance class. It is bounded above by the genus of the knot, and bounded below by the slice genus, two well-studied invariants. In this talk we consider the concordance genus of 11–crossing prime knots. We will consider several examples, focusing on techniques used to calculate the concordance genus. (Received August 27, 2012)

1083-57-192 **Helen Wong*** (hwong@carleton.edu), 1 N College ST, Northfield, MN 55057, and **Francis Bonahon**, 3620 S. Vermont Avenue, KAP 104, Los Angeles, CA 90089. *A quantum trace map.*

We describe a combinatorial map from the Kauffman skein algebra of a surface to its quantum Teichmuller space. We will also mention some applications of this map. (Received August 27, 2012)

1083-57-197 **Scott Baldridge*** (sbaldrid@math.lsu.edu), 380 Lockett Hall, Department of Mathematics, Louisiana State University, Baton Rouge, LA 70803, and **Ben McCarty**, University of Memphis. *Knotted Legendrian Tori in* $\mathbb{R}^5$. Preliminary report.

A special Lagrangian cone $C \subset \mathbb{C}^3$ can be characterized by its associated link $L = C \bigcap S^5$ (the link of the singularity), which is of interest to physicists when the links are minimal knotted Legendrian tori. In this talk we discuss new ways to construct knotted Legendrian tori in $\mathbb{R}^5$ in general and why these constructions make it easier to study their contact homology. (Received August 27, 2012)

1083-57-201 **Meredith Casey*** (mcasey@gatech.edu), 251 10th St NW D305, Atlanta, GA 30318. *Branched Coverings of Contact Manifolds.*

Branched coverings are often used in low-dimensional topology to study contact manifolds. In this talk we will first discuss what is known about the construction of contact manifolds via branched covers, particularly the construction of covers branching over a knot in (S^3, ξ_{std}). We will then present methods for constructing contact manifolds using branched covers and open book decompositions. Using this construction, and given only the braid word of the branch locus and the covering map, what all can be determined about the covering contact manifold? The remainder of the talk will discuss answers to this question, with particular emphasis on determining if the covering contact structure is tight or overtwisted. (Received August 28, 2012)

1083-57-213 **John A Baldwin**, **David Shea Vela-Vick*** (shea@math.lsu.edu) and **Vera Vertesi**. *The equivalence of transverse link invariants in knot Floer homology.*

The Heegaard Floer package provides a robust tool for studying contact 3-manifolds and their subspaces. Within the sphere of Heegaard Floer homology, several invariants of Legendrian and transverse knots have been defined. The first such invariant, constructed by Ozsvath, Szabo and Thurston, was defined combinatorially using grid diagrams. The second invariant was obtained by geometric means using open book decompositions by Lisca, Ozsvath, Stipsicz and Szabo. We show that these two previously defined invariant agree. Along the way, we define a third, equivalent Legendrian/transverse invariant which arises naturally when studying transverse knots which are braided with respect to an open book decomposition. (Received August 28, 2012)

1083-57-219 **Allison Gilmore*** (gilmore@math.ucla.edu). *A knot Floer invariant of certain framed graphs.* Preliminary report.

I will introduce an algebraic invariant of framed braid-like trivalent graphs inspired by knot Floer homology, then explore its properties with respect to the Murakami-Ohtsuki-Yamada relations and the operation of braid closure. I will close by relating this invariant to knot Floer homology of singular knots and to Soergel bimodules. (Received August 28, 2012)

1083-57-220 **Charles D. Frohman** and **Joanna Kania-Bartoszynska*** (jkaniaba@nsf.gov), 4201 Wilson Blvd., Arlington, VA 22230. *Quantum invariants of 3-manifolds and their asymptotics.*

We will discuss several quantum invariants of 3-dimensional manifolds, their asymptotic behavior, and connections to other topological invariants. (Received August 28, 2012)

1083-57-224 **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 Danielle O'Donnol (Imperial College London). (Received August 28, 2012)

1083-57-234 **Alexander N. Shumakovitch*** (shurik@gwu.edu), The George Washington University, Department of Mathematics, Monroe Hall, 2115 G St. NW, room 240, Washington, DC 20052. *On torsion in the Khovanov homology of knots.* Preliminary report.

We discuss which orders of torsion can appear in the Khovanov homology of knots with Z_2-homological width 2 and 3. (Received August 29, 2012)

60 ► Probability theory and stochastic processes

1083-60-10 **Indranil SenGupta*** (indra.sengupta@gmail.com), Department of Mathematics, North Dakota State University, Fargo, ND, and **Maria C Mariani**, **I Florescu** and **M P Beccar-Varela**. *Stochastic models applied to earthquake dat.*

In this work we study scale invariant functions and stochastic Lévy models and we apply them to Geophysical data. We show that a pattern arises from the scale invariance property and Lévy flight models that may be used to estimate parameters related to some major event - major earthquake. We relate this to some results in finance. (Received June 12, 2012)

1083-60-12 **Parisa Fatheddin*** (fatheddin@math.utk.edu), 227 Ayres Hall, 1403 Circle Drive, Knoxville, TN 37996-1320, and **Jie Xiong** (jxiong@math.utk.edu), 227 Ayres Hall, 1403 Circle Drive, Knoxville, TN 37996-1320. *Large 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)

1083-60-24 **Julius N Esunge*** (jesunge@umw.edu), University of Mary Washington, Fredericksburg, VA 22401, and **Eriyoti Chikodza**. *Risk Minimization Using G-Expectation.*

We investigate the minimization of convex risk using g-expectation, in the context of Levy markets. Our main contribution is a scheme for solving forward backward stochastic differential equations (FBSDEs, for short) for jump diffusions. It is shown that the solution obtained using the scheme minimizes the convex risk induced by the g-expectation. We also prove that whenever the scheme is realizable, the solution obtained is unique. (Received July 17, 2012)

1083-60-35 **Jianfu Chen**, **Jin Ma** and **Hong Yin*** (hyin@brockport.edu). *The Wellposedness of Forward-Backward Stochastic Differential Equations with Discontinuous Coefficients.*

In this paper we are interested in the well-posedness of a "regime-switching" type of fully coupled forward-backward SDE (FBSDE) in which the forward drift coefficient is piecewise continuous in the backward component of the solution. Such a discontinuity violates the usual continuity assumptions (on the backward variables) of all existing results, and example shows that non-uniqueness can easily happen when the forward diffusion is degenerate even when the monotonicity conditions are in force. In a Markovian setting with non-degenerate forward diffusion, we show that, by the standard mollification method, a decoupling function can still be constructed, and it is a solution to the corresponding quasilinear PDE in the sense of distribution. With such a

decoupling function we first show that the FBSDE admits a weak solution in the sense of Antonelli-Ma (2003) and Ma-Zhang-Zheng (2008). We then prove that the pathwise uniqueness holds, whence the strong well-posedness of the FBSDE in the spirit of Yamada-Watanabe Theorem. Our main tool is a comparison result for SDEs with measurable drift based on the so-called Krylov estimates. This problem is motivated by a practical issue in regime-switching term structure interest rate models. (Received July 28, 2012)

1083-60-36 **Gustavo Didier*** (gdidier@tulane.edu), 6823 St. Charles Avenue, New Orleans, LA 70118. *Probabilistic and inferential aspects of self-similarity in the multivariate setting.*

A stochastic process is said to be self-similar (s.s.) when its law scales according to a power $0 < H < 1$, the so-called the Hurst parameter. An example of a self-similar process is the classical Brownian Motion.

In this talk, we will give a broad view of related probabilistic and inferential aspects of self-similarity in the multivariate setting, for which there are still many open research questions. Of particular interest is a class of self-similar processes, called Operator Fractional Brownian Motions (OFBMs). We establish integral representations of OFBMs and study issues such as spectral properties, time reversibility and the identi fiability of the parametrization. We will then compare the Fourier and wavelet spectra of OFBMs, and discuss a recently developed wavelet-based inferential method. (Received August 02, 2012)

1083-60-53 **Aurel Iulian Stan*** (stan.7@osu.edu) and **Alberto Lanconelli**. *Some Hölder inequalities for norms of Poissonian Wick products.* Preliminary report.

Some important inequalities for the norms of Wick products, generated by the Gaussian probability measures and the probability distributions of the square of normal random variables, have been proven in the recent years. These inequalities involve the second quantization operator of some constants times the identity operator. We will prove first some sharp inequalities for the L^1, L^2, and L^∞ norms of Poissonian Wick products. We use then Stein Analytic Interpolation Theorem to find inequalities about the L^p norms of Poissonain Wick products, for p other than 1, 2, and ∞. (Received August 12, 2012)

1083-60-78 **Barbara Rüdiger*** (ruediger@uni-wuppertal.de), Mathematics Department, , FB C, Bergische Universität Wupppertal, 52119 Wuppertal, Germany. *Structural stability of SPDEs with Lévy noise and applications to finance.*

In [1] we proved the structural stability of SPDEs with Lévy noise, when perturbing the (Lipschitz) drift- and noise coefficients or when differentiating w.r.t initial data. This can in particular be applied [3] to analyze the structural stability of the HJM- forward interest rate model with Lévy noise analyzed in [2] as well as its derivatives [3].

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(Received August 18, 2012)

1083-60-80 **Wojbor A Woyczynski*** (waw@case.edu), Department Of Statistics, Case Western Reserve University, Cleveland, OH 44106. *Nonlinear and Nonlocal Evolution Equations: Porous Media and Evolutionary Ecology.*

One of the motivations of our work (joint with B. Jourdain and S. Meleard) was to generalize the probabilistic approximation of the classical strongly nonlinear porous medium equation, which describes percolation of gases through porous media. The usual Barenblatt solutions have a very rigid type of self-similarity and our goal was to allow a more general class of anomalous diffusions in the model. The talk will discuss the relevant mathematical difficulties related to the combination of strong nonlinearity and fractional Laplacian operators.

Another model that led us to new types of nonlinear and nonlocal (stochastic in some cases) evolution equations was related to the phenomenon of Darwinian evolution resulting from the interplay of phenotypic variation and natural selection through ecological interactions. The population was modeled as a stochastic point process whose generator captures the probabilistic dynamics over continuous time of birth, random mutation, and death, as influenced by each individual's trait values, and interactions between individuals. In the case we were interested in, the probability distribution of mutations had a heavy tail and belonged to the domain of attraction of a stable law and the corresponding diffusion admitted jumps. (Received August 19, 2012)

1083-60-89 **Meng Xu*** (mxu@rockefeller.edu), 500 E. 63rd St., New York, NY 10065, and **Sivaguru Sritharan**. *Malliavin Calculus for Stochastic Point Vortex and Lagrangian Models.*

We explore the properties of solutions of two stochastic fluid models for viscous flow in two dimensions. We establish the absolute continuity of the law of the corresponding solution using Malliavin calculus. (Received August 21, 2012)

1083-60-94 **Tyrone E. Duncan*** (duncan@math.ku.edu), Mathematics Department, Snow Hall, 1460 Jayhawk Blvd., Lawrence, KS 66045. *Some Solvable Stochastic Control Problems.* Preliminary report.

Some stochastic control problems are explicitly solved by providing optimal controls and optimal costs. These problems are solved by a generalization of the method of completion of squares from elementary algebra. This method provides directly optimal controls and optimal costs. This method is more elementary and more direct than the well known methods of solutions of Hamilton-Jacobi-Bellman equations and the application of the stochastic maximum principle. The stochastic control problems that are solved include finite dimensional controlled linear stochastic systems driven by arbitrary continuous stochastic processes and having quadratic cost functionals, controlled linear stochastic equations in an infinite dimensional Hilbert space with fractional Brownian motions having the Hurst parameter in the interval (1/2,1), linear stochastic systems in finite or infinite dimensional spaces with Brownian motions and costs that are exponentials of quadratic costs, the control of a Brownian motion in the two-sphere and the control of a Brownian motion in the real hyperbolic plane. Some of these results are joint work with B. Maslowski and B. Pasik-Duncan. (Received August 22, 2012)

1083-60-104 **Irina Holmes*** (icraci1@math.lsu.edu), Department of Mathematics, 303 Lockett Hall, Baton Rouge, LA 70803, and **Ambar N Sengupta** (sengupta@math.lsu.edu), Department of Mathematics, 303 Lockett Hall, Baton Rouge, LA 70803. *A Gaussian Radon Transform for Banach Spaces.*

The Gauss Radon transform, developed as an infinite-dimensional answer to the traditional Radon transform on $\mathbb{R}^n$, makes use of Gaussian measures on infinite-dimensional spaces. In this talk we describe the development of the Gauss Radon transform for Banach spaces, within the abstract Wiener space framework. (Received August 23, 2012)

1083-60-134 **Hakima Bessaih*** (bessaih@uwyo.edu), Department of Mathematics, Laramie, WY 82071, and **Zdislaw Brzezniak** and **Annie Millet**. *Splitting up method for a 2D stochastic Navier-Stokes equations.* Preliminary report.

We consider a 2D Stochastic Navier-Stokes equations with a multiplicative noise. Here, we deal with the convergence of some iterative schemes. The stochastic equation is split into two problems which are simpler for numerical computations. Moreover, an estimate "in probability" of the approximation error is given. (Received August 25, 2012)

1083-60-164 **Indika P Wickramasinghe*** (indika.wickramasinghe@enmu.edu), Mathematical Sciences, ENMU Station 18, 1500 S Ave K, Portales, NM 88130, and **Alex Trindade** (alex.trindade@ttu.edu), Dept of Mathematics & Statistics, Broadway and Boston, Lubbock, TX 79409. *Approximating the unit roots probabilities of the estimator of first order moving average model.*

We propose a method to approximate unit roots probabilities of the first order moving average model, MA (1) under the maximum likelihood estimator and the Gaussian distribution. The accuracy and the simplicity of the implementation are some of the advantages of this method. This proposed approach is based on saddlepoint approximation, which was introduced by Daniels in 1954. Under this method, the maximum likelihood (ML) estimator of the MA (1) parameter is expressed as a quadratic estimating equation (QEE). Monotone QEE whose unique root is the estimator of interest, the profiling out of nuisance parameters, and the accurate saddlepoint approximations to the cumulative distribution function (CDF) of the ML estimator are some of the key steps of the method. Results obtained are compared with the results presented by Cryer and Ledolter (1981) using a different approach. The extensions of this method for any sample size and for non-Gaussian case are considered. (Received August 27, 2012)

1083-60-185 **Nathaniel Eldredge*** (neldredge@math.cornell.edu), 593 Malott Hall, Cornell University, Ithaca, NY 14853, and **Laurent Saloff-Coste** (lsc@math.cornell.edu), 567 Malott Hall, Cornell University, Ithaca, NY 14853. *Widder's theorem for symmetric local Dirichlet forms.*

Classically, Widder's theorem says that any nonnegative solution $u(t,x)$ of the heat equation $(\partial_t - \frac{1}{2}\Delta)u = 0$ on $(0,T) \times \mathbb{R}^d$ is uniquely determined by its initial values at time $t = 0$; in particular, no growth conditions on u need be assumed. We present an extension of this theorem in which $\mathbb{R}^d$ is replaced by a metric measure space equipped with a symmetric, strictly local, regular Dirichlet form $(\mathcal{E}, \mathbb{D})$ satisfying certain assumptions. Examples include Riemannian and sub-Riemannian manifolds as well as various fractals. A key ingredient is a parabolic Harnack inequality for local weak solutions of the heat equation defined by $(\mathcal{E}, \mathbb{D})$. (Received August 27, 2012)

1083-60-214 **Natesh Pillai***, 1 Oxford Street, Cambridge, MA 02138, and **Martin Lysy**. *Statistical Inference for stochastic differential equations driven by Fractional Brownian Motion.*

We present a methodology for doing parameter estimation for stochastic differential equations driven by fractional Brownian motion. Our approach is computational: we present a Gibbs sampling algorithm which will give posterior draws of the parameter conditioned on discretely observed diffusions driven by fractional noise. This approach can easily be extended for other driving noises which are "rough paths". Joint work with Martin Lysy. (Received August 28, 2012)

1083-60-221 **Scott A McKinley*** (scott.mckinley@ufl.edu), **David B Hill**, **John Mellnik** and **M. Gregory Forest**. *Fractional Kinetics of Microparticles in Human Mucus.*

Recent particle tracking data gathered by microrheologists reveals that anomalous diffusion is ubiquitous in the behavior of microparticles in biological fluids. The proper choice of a mathematical model depends on the character of the deviation from Brownian diffusion. This deviation is influenced by both properties of the particle and of the fluid: bead size and shape, surface chemistry, fluid microstructure, etc. In this talk we will see that, for a range of particle sizes and mucin concentrations, the observed data is consistent with fractional Brownian motion description that has a concentration-dependent coefficient and Hurst parameter. (Received August 28, 2012)

1083-60-235 **Jonathan Weitsman*** (j.weitsman@neu.edu), Department of Mathematics, Northeastern University, Boston, MA 02115. *Measures on Banach Manifolds and Supersymmetric Quantum Field Theory*

We show that the functional integrals appearing in a class of supersymmetric quantum field theories may be interpreted as well-defined measures on certain Banach manifolds. We give several examples, and conjecture that these measures are finite.

Assuming the finiteness conjecture, the integral of a certain bounded function should give quantities, such as topological invariants, which are of wide interest in geometry and topology. (Received August 30, 2012)

65 ► Numerical analysis

1083-65-228 **Boyce E. Griffith*** (boyce.griffith@nyumc.org), Leon H. Division of Cardiology, Smilow Research Building 8th Floor, 550 First Avenue, New York, NY 10016. *An approach to using finite element mechanics models with the immersed boundary method.*

The immersed boundary (IB) method is a framework for modeling systems in which an elastic structure is immersed in a viscous incompressible fluid. The IB formulation of such problems describes the elasticity of the structure in Lagrangian form and describes the momentum, viscosity, and incompressibility of the fluid-structure system in Eulerian form. Interactions between Lagrangian and Eulerian variables are mediated by integral transforms with delta function kernels. When discretized, the Lagrangian equations are approximated on a curvilinear mesh, the Eulerian equations are approximated on a Cartesian grid, and a regularized version of the delta function is used in approximations to the Lagrangian-Eulerian interaction equations. This talk will focus on a describing a version of the IB method that allows us to discretize the structure via standard Lagrangian finite element (FE) methods. A key feature of our numerical scheme that we shall highlight is that it enables the use of Lagrangian meshes with mesh spacings that are independent of the grid spacing of the background Eulerian grid. Results from computational experiments will be presented. (Received August 28, 2012)

76 ► Fluid mechanics

1083-76-74 **Jacek K Wrobel*** (jwrobel@tulane.edu), Mathematics Department, Tulane University, 6823 St. Charles Ave, New Orleans, LA 70118, **Michael R Booty** (michael.r.booty@njit.edu), Department of Mathematical Sciences, New Jersey Institute of Technology, University Heights, Newark, NJ 07102, and **Michael S Siegel** (michael.s.siegel@njit.edu), Department of Mathematical Sciences, New Jersey Institute of Technology, University Heights, Newark, NJ 07102. *Modeling Microscale Tipstreaming in a Microfluidic Flow Focusing Device.*

In order understand the mechanisms behind tipstreaming process and to gain more control of this process we model a droplet formation regime in microfluidic device. In that regime threads form periodically and the tread formation gives way to tipstreaming of micrometer-scale droplets. We propose to model the regime by the bubble in soluble surfactant solution due to an axisymmetric extensional Stokes flow along the centerline of the drop. The flow focuses two-phase fluid through a narrow opening or orifice in a vertical wall. The aperture is centered at the centerline of the bubble. The concentration of bulk soluble surfactant was found to significantly effect the mode of formation and size of the emitted droplets. By carefully controlling the surfactant concentration and other flow quantities, droplets can be created that are an order of magnitude or more smaller than the scale of both the device and droplets produced in the absence of surfactant. (Received August 17, 2012)

1083-76-147 **Sarah D Olson*** (sdolson@wpi.edu), WPI, Mathematical Sciences, 100 Institute Rd, Worcester, MA 01609. *Hydrodynamic Interactions of Hyperactivated Sperm.*

Hyperactivated sperm motility is correlated to an increase in calcium concentration within the flagellum and is characterized by highly asymmetrical waveforms and circular trajectories. Previous computational studies of flagellum with symmetrical waveforms have shown that multiple sperm swimming with waveforms that are out of phase will eventually phase lock due to hydrodynamic interactions. The focus of this talk is to study the hydrodynamic interactions of hyperactivated sperm swimming in proximity. (Received August 26, 2012)

1083-76-175 **J C Chrispell*** (john.chrispell@iup.edu), 217 Stright Hall, Mathematics Department, Indiana University of Pennsylvania, Indiana, PA 15705, and **L J Fauci** and **M Shelley**. *An actuated elastic sheet interacting with passive and active structures in a viscoelastic fluid.*

Modeling viscoelastic fluids driven by actuated immersed boundaries is of significance in both biological and industrial settings. To model these flows a nonlinear constitutive equation describing the evolution of the viscoelastic contribution to the fluid stress tensor is included in the governing equations. Here we discuss the use of an immersed boundary framework to simulate fluid flows governed by a Navier-Stokes/Oldroyd-B model. A description of the numerical method and its stabilization is given. We discuss recent numerical simulations of the locomotion and hydrodynamic synchronization of undulating sheets, as well as the interaction of swimming sheets with solid boundaries. (Received August 27, 2012)

1083-76-186 **Xiaoliang Wan*** (xlwan@math.lsu.edu), 226 Lockett Hall, Louisiana State University, Baton Rouge, LA 70803. *A study on hydrodynamic stability using large deviation theory.*

In this work, we study the nonlinear instability of two-dimensional Poiseuille flows in a long channel from the large deviation point of view. We start from the Navier-Stokes equations perturbed by small space-time white noise. When the amplitude of the noise goes to zero, the Frendlin-Wentzell (F-W) large deviation theory for random perturbations of dynamical systems provides the insight for the transition between metastable states in the phase space through the minimizers of the F-W action functional. We use numerical techniques to minimize the F-W action functional and use it to define a new critical Reynolds number for the nonlinear instability. The new stability theory is applied to study two-dimensional Poiseuille flows in a long channel. (Received August 27, 2012)

1083-76-216 **Yuan Teng**, **Weixiong Wang** and **Damir B Khismatullin*** (damir@tulane.edu), Department of Biomedical Engineering, Tulane Universiy, 500 Lindy Boggs Center, New Orleans, LA 70118. *Multiple-Particle-Tracking Microrheology for Biological Materials.*

In multiple-particle-tracking microrheology (MPTM), rheological properties of fluids are determined from the Stokes-Einstein theory applied to Brownian motion of small suspended particles. In this talk, we discuss the current progress and present our recent data on the development of MPTM algorithms for accurate measurement of viscosity and other material constants of biological fluids and living cells. (Received August 28, 2012)

1083-76-222 **Christel Hohenegger*** (choheneg@math.utah.edu), 155 S 1400 E Room 233, Salt Lake City, UT 84112-009, and **Scott A. McKinley**. *Fluctuating hydrodynamics of immersed particles in a Maxwellian fluid.*

Multibead passive microrheology aims at characterizing fluid properties via statistically measurable quantities like mean square displacement and autocorrelation. To correctly model the correlations between particles, it is necessary to simulate the fluid itself and to include a thermally fluctuating force in the Navier Stokes equations. For a viscous fluid, this has been successfully achieved by the stochastic immersed boundary method of Atzberger *et. al.*. Our first goal is to extend this algorithm to a biological fluid. Therefore, we develop a stochastic immersed boundary method for a Maxwellian fluid (viscoelastic). Second, we seek to find a signal due to the fluid's memory in the statistics of the particles velocity autocorrelation. (Received August 28, 2012)

81 ► Quantum theory

1083-81-120 **Anton Zeitlin*** (zeitlin@math.columbia.edu), New York, NY 10027. *Algebraic structures of stringy sigma models and homotopy algebras.*

I will talk about homotopy BV-algebras related to Courant/Vertex algebroids and their connection to the beta-functions of sigma models in the context of perturbed conformal field theories. (Received August 24, 2012)

1083-81-121 **Anton Zeitlin*** (zeitlin@math.columbia.edu), New York, NY 10027. *On the continuous series for* $\widehat{sl(2,R)}$.

We construct the representations of $\widehat{sl(2,R)}$ in the spirit of Wakimoto modules, where the role of beta-gamma system is played by the Lie algebra of the loop $ax+b$-group and its close relatives. The approach involves a graphical representation of the correlation functions of the generators and renormalization of the appearing divergencies. (Received August 24, 2012)

1083-81-139 **Cristian Lenart**, **Satoshi Naito**, **Daisuke Sagaki** and **Anne Schilling*** (anne@math.ucdavis.edu), Department of Mathematics, One Shields Ave, University of California, Davis, CA 95616, and **Mark Shimozono**. *A uniform combinatorial model for Kirillov-Reshetikhin crystals and specialized Macdonald polynomials.* Preliminary report.

Our goal is to prove that $P_\lambda(q) = X_\lambda(q)$, where $P_\lambda(q)$ is the Macdonald polynomial $P_\lambda(q,t)$ specialized at $t = 0$ and $X_\lambda(q)$ is the graded character of a simple Lie algebra coming from tensor products of Kirillov-Reshetikhin (KR) modules. In pursuit of this goal, we present a new explicit formula for the X polynomials, by characterizing the previously inexplicit formula using projected Lakshmibai-Seshadri (LS) paths, in terms of the parabolic quantum Bruhat graph (a combinatorial device coming from quantum cohomology of homogeneous spaces). This is achieved by establishing a lifting of the projected LS paths to the level-0 weight poset, which was first introduced by Littelmann. We also show a generalization of results by Deodhar which involves the compatibility of the quantum Bruhat graph with the cosets for every parabolic subgroup of the Weyl group. This should be the key structure to establish $P = X$. (Received August 26, 2012)

1083-81-174 **Adriano Moura*** (aamoura@ime.unicamp.br), Universidade Estadual de Campinas, Departamento de Matemática, Campinas, SP 13083-859, Brazil. *Prime representations and self extensions of representations of quantum affine algebras.*

Given an abelian category, one of the natural questions to be addressed is that of understanding the space of extensions between its simple objects. For the category of finite-dimensional representations of an affine Kac-Moody algebra, this question has been answered in the last few years. The quantum version of this category is far more complicated and the answer to this question remains open. We shall discuss some ideas towards the answer of this problem and show, via examples, that the quantum answer is different from the classical one in an essential way. An interesting feature of the category of finite-dimensional representations of a quantum affine is that it has simple objects which are not prime, i.e., which are isomorphic to a tensor product of two nontrivial simple objects. It is then natural to try to classify the prime ones. Although this classification is also unknown, the amount of known examples of prime modules has been growing. In the main part of this talk we shall present results from a joint paper with V. Chari and C. Young relating the study of prime representations to that of the space of self extensions of simple modules. (Received August 27, 2012)

92 ► Biology and other natural sciences

1083-92-2 **Anita Layton***, Duke University, Department of Mathematics, Durham, NC.
Mathematical modeling of renal hemodynamics: Feedback dynamics and coupled oscillators.

We have formulated a mathematical model for the rat afferent arteriole (AA), glomerulus, and short loop of Henle, and used that model to study the interactions between the tubuloglomerular feedback (TGF) and myogenic mechanism, the two key mechanisms that mediate autoregulation in the kidney. Blood flow is described by Poiseuille flow. The AA model consists of a series of arteriolar smooth muscle cells, each of which represents ion transport, cell membrane potential, cellular contraction, gap junction coupling, and wall mechanics. The myogenic response representation is based on the hypothesis that the voltage dependence of calcium channel openings responds to transmural pressure so that the vessel constricts when pressure increases. The glomerular filtration model is based on the model by Deen et al. (AJP 1972). The TGF model represents the pars recta, descending limb, and thick ascending limb, and predicts tubular fluid flow rate and [Cl-] along the loop. The model can be used as a fundamental component in a multi-scale renal microvasculature model for investigations of pathogenesis of hypertensive renal diseases. This research was supported in part by NIH grant DK-89066 and NSF grant DMS-0715021. (Received March 25, 2011)

1083-92-31 **Alex Chen*** (achen@samsi.info), **Sam Lai**, **Scott McKinley**, **Peter Mucha** and **Greg Forest**. *Deterministic and Stochastic Modeling of Antibody Sequestration of Viral Populations in Mucosal Layers.*

We study the co-diffusion processes of viral and antibody populations through mucosal layers. Antibodies play an important part in immune defense by binding to the surface of virions and effectively neutralizing them. Less understood is the role of antibodies in arresting the movement of virions by means of their weak affinity for the mucin network, housed within mucosal layers.

Many previous studies on viral infectivity have focused on infection in cells and have assumed a well-mixed viral and antibody regime. Thus, antibody attachment kinetics is often discounted and the number of antibodies present in a viral attack is overestimated.

We introduce several models of virus and antibody co-diffusion based on a combination of PDE master equation and stochastic path simulation techniques. These models incorporate probabilistic antibody attachment kinetics as well as diffusion processes for movement. The relative advantages of each model for realistic simulation and computation speed are examined. Results of the study illustrate the importance of mucosal layers as buffer zones impeding the progress of virus toward vital tissue. (Received July 24, 2012)

1083-92-52 **Katarzyna A Rejniak*** (kasia.rejniak@moffitt.org), 12902 Magnolia Drive, SRB-4, 24000G, Tampa, FL 33612. *The role of tumor tissue architecture on anticancer drug penetration and efficacy.*

Poor penetration of the tumor tissue by drug particles contributes to low efficacy of therapeutic compounds, and, in many cases, results in the failure of the Phase II clinical trials, even if the therapeutic compounds were successful in laboratory experiments. We developed a computational model of drug penetration that operates on the microscopic tissue scale and recreates various physico-chemical conditions of the tumors. This model includes explicitly defined tissue morphology that is comprised of individual and/or stromal cells surrounded by the interstitial space filled with the fluid that impacts drug transport. We investigated the dynamics of a class of drugs activated in regions characterized by either low oxygen or high acid levels, and showed that they may lead to shifting of the tissue metabolic profile. Our computational results showed that there is a non-linear relation between tissue permeability, its cellular density and penetration of drug molecules due to the convective interstitial transport. Moreover, we demonstrated that heterogeneity in tissue composition, such as irregular cell configurations, might solely be responsible for the emergence of tissue zones that are not exposed to drugs in concentrations sufficient to provide therapeutic action. (Received August 12, 2012)

1083-92-114 **Laura Ann Miller*** (lam9@unc.edu), CB 3250 Phillips Hall, Department of Mathematics, Chapel Hill, NC 27599. *Rolling up with the flow to reduce drag and flutter: A study of broad leaves.*

Flexible plants, fungi, and sessile animals reconfigure in wind and water to reduce the drag forces acting upon them. In strong winds and floodwaters, leaves roll up into cone shapes that reduce drag compared to rigid objects of similar surface area. Less understood is how a leaf attached to a flexible petiole (leafstalk) will roll-up stably in an unsteady flow. A combination of experiments and numerical simulations is used to describe the unsteady forces acting upon flexible sheets attached to flexible beams. The results from the simplified physical

and mathematical models are then compared to measurements taken from broad leaves. (Received August 23, 2012)

1083-92-156 **Christina L Hamlet*** (chamlet@tulane.edu) and **Laura A. Miller**. *Flow Generated by Changing Pulse Patterns of the Upside Down Jellyfish.*

The mostly sessile upside-down jellyfish Cassiopea spp. is used to study the effects of jellyfish kinematics on the flow of surrounding fluid. Using the immersed boundary method, we investigate the bulk flow of fluid around the pulsing bell of a 2D jellyfish. The influence of the timing of pauses between muscle contractions and presence of secondary structures as well as the implications for particle transport are discussed. (Received August 26, 2012)

1083-92-209 **John Fricks*** (fricks@stat.psu.edu), 325 Thomas Bldg, University Park, PA 16801. *Detection of Heterogeneity in Microrheological Experiments.* Preliminary report.

Passive microrheological experiments attempt to probe the structure of soft matter through the observation of the diffusion paths of small particles. One outstanding issue is the detection of heterogeneity across multiple paths, which would imply a spatial heterogeneity of the material under study. By applying standard and novel methods from the statistical time series literature, this talk will present some possible quantitative approaches to these problems. This is joint work with a significant group of researches including Gustavo Didier (Tulane U), Scott McKinley (U Florida), and a group at (U North Carolina) led by Greg Forest and David Hill. (Received August 28, 2012)

1083-92-232 **Mark E Whidden*** (mwhidden@math.fsu.edu), 1017 Academic Way, Love Building, Room 208, Tallahassee, FL 32303, and **Nick G Cogan** and **Matt R Donahue**. *Numerical Computations of a Multiphase System for Biofilm Development.*

In recent years, many biological phenomena involving complex mechanical and biochemical interactions of multiple components have been successfully modeled using a multiphase framework, including tumorigenesis, biofilm channel formation, and developmental processes. In this talk, I will examine the computational issues that are inherent in the numerical simulation of a particular multiphase model for the biofilm formation that occurs in Pierce's Disease, and demonstrate some particular schemes which are both efficient and robust. (Received August 29, 2012)

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