### Weekly Seminar & Events Bulletin

**November 25th, 2018 - December 1st, 2018**

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**Monday, November 26, 2018**

<table>
<thead>
<tr>
<th>Time</th>
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| 4:00pm-5:20pm | **Group, Lie and Number Theory** -- Andrei Jorza (University of Notre Dame)  
**Taylor expansions of two-variable $p$-adic L-functions**  
-- 4088 East Hall |                  |
| 4:00pm-5:00pm | **Complex Analysis, Dynamics and Geometry** -- John Yang (U(M))  
**Dynamics of Irreducible Polynomials with an Attracting Point**  
-- 3088 East Hall |                  |
| 4:00pm-5:00pm | **Integrable Systems and Random Matrix Theory** -- Nick Witte (Massey University (New Zealand))  
**Computing Indices of Variance, Cumulants of Mutual Information Entropy and Allied Statistics in Random Matrix Theory**  
-- 1866 East Hall |                  |
| 4:00pm-5:00pm | **Student Combinatorics** -- (University of Michigan) **TBA**  
-- 3866 East Hall |                  |
| 4:00pm-6:00pm | **Geometry & Physics** -- Thomas Walpuski (MSU) **Super-rigidity and Castelnuovo's bound**  
-- 4096 East Hall |                  |

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**Tuesday, November 27, 2018**

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| 3:00pm-4:00pm | **Student Geometry/Topology** -- Montek Gill (University of Michigan)  
**Solving Thurston's hyperbolic gluing equations over commutative rings**  
-- 1866 East Hall |                  |
| 4:00pm-5:00pm | **Colloquium Series** -- Andrei Negut (MIT) **Braids and sheaves: a geometric incarnation of Khovanov-Rozansky homology**  
-- 1360 East Hall |                  |

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**Wednesday, November 28, 2018**

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<th>Time</th>
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| 3:00pm-3:50pm | **Student Arithmetic** -- Jonathan Gerhard (University of Michigan)  
**An Introduction to Arithmetic Statistics**  
-- 4096 East Hall |                  |
| 4:00pm-5:00pm | **Financial/Actuarial Mathematics** -- Sebastian Hermann (UM)  
**Inventory Management for High-Frequency Trading with Imperfect Competition**  
-- 1360 East Hall |                  |
| 4:00pm-5:30pm | **RTG Seminar on Geometry, Dynamics and Topology** -- Chris Leininger (UIUC)  
**Polygonal billiards, Liouville currents, and rigidity**  
-- 3866 East Hall |                  |
| 4:00pm-5:20pm | **Algebraic Geometry** -- Andrei Negut (MIT) **Algebraic cycles on Hilb(K3) and the Virasoro algebra**  
-- 4096 East Hall |                  |

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**Thursday, November 29, 2018**

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| 1:00pm-2:30pm | **Student Homotopy Theory** -- Yunze Lu (University of Michigan)  
**Foundations of equivariant stable homotopy theory**  
-- 2866 East Hall |                  |
| 3:00pm-4:00pm | **Topology** -- Becca Winarski (U(M))  
**Generalized twisted rabbits and trees**  
-- 3088 East Hall |                  |
| 3:00pm-4:00pm | **Commutative Algebra** -- Takumi Murayama (University of Michigan)  
**The gamma construction and applications**  
-- 4088 East Hall |                  |
| 4:00pm-5:00pm | **Student Algebraic Geometry** -- Gilyoung Cheong (UM)  
**Cohen–Lenstra heuristics**  
-- 3866 East Hall |                  |
| 4:00pm-5:00pm | **Differential Equations** -- Ben Bellis (Umich)  
**Resolvent Estimates for Non-self-adjoint Schrödinger Operators**  
-- 4088 East Hall |                  |
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<td>3:00pm-4:00pm</td>
<td><strong>Applied Interdisciplinary Mathematics (AIM)</strong> -- John Wettlaufer (Yale University) <em>Failing elastically and succeeding stochastically</em>  -- 1084 East Hall</td>
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<tr>
<td>3:00pm-5:00pm</td>
<td><strong>Geometry</strong>  -- Jane Wang (MIT) <em>The dynamics and geometry of dilation surfaces</em>  -- 3866 East Hall</td>
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<td>3:00pm-4:00pm</td>
<td><strong>Combinatorics</strong> -- Greg Muller (University of Oklahoma) <em>Linear recurrence relations with periodic solutions</em>  -- 2866 East Hall</td>
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<td><strong>Junior Colloquium Series</strong> -- Zaher Hani (University of Michigan) <em>Nonlinear Waves: statistical mechanics and turbulence</em>  -- 3088 East Hall</td>
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<td>5:00pm-6:00pm</td>
<td><strong>Student Machine Learning</strong> -- Alexandros Georgakopoulos (University of Michigan) <em>A Variance Minimization Criterion to Active Learning on Graphs</em>  -- 4088 East Hall</td>
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Abstracts for the week of November 25th, 2018 - December 1st, 2018

**Group, Lie and Number Theory**

**Monday, November 26, 2018, 4:00pm-5:20pm**

4088 East Hall

**Andrei Jorza (University of Notre Dame)**

**Taylor expansions of two-variable p-adic L-functions**

p-adic L-functions attached to p-adic families of cuspidal representations we first used by Greenberg and Stevens in their proof of the Mazur-Tate-Teitelbaum conjecture. They have since been constructed in many instances, most generally for ordinary families on unitary groups by Eischen, Harris, Li and Skinner. I will describe recent work with Mladen Dimitrov on their Taylor expansions that relies on partial p-adic families that vary the local representations at some places above p.

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**Complex Analysis, Dynamics and Geometry**

**Monday, November 26, 2018, 4:00pm-5:00pm**

3088 East Hall

**John Yang (U(M))**

**Dynamics of Irreducible Polynomials with an Attracting Point**

Let f be a polynomial (of any degree) with an attracting periodic point. Suppose that f is irreducible—that is, f has a connected Julia set, and the dynamics of f is not the product of gluing together two or more simpler polynomials. For such f, we provide an explicit model of the Julia set which is homeomorphic to it if and only if the Julia set is locally connected. We then state a local connectivity result for the Julia set in the case when the critical points for f have non-strongly recurrent combinatorics. Lastly, we characterize the strong recurrence property in terms of a new kind of an algebraic structure on the Bernoulli shift.
Integrable Systems and Random Matrix Theory  
Monday, November 26, 2018, 4:00pm-5:00pm  
1866 East Hall  
Nick Witte (Massey University (New Zealand))  
Computing Indices of Variance, Cumulants of Mutual Information Entropy and Allied Statistics in Random Matrix Theory

Two fundamental examples, amongst numerous others, of statistics arising in random matrix theory are the variance of the index and low order cumulants of the mutual information entropy. The variance of the index is concerned with the fluctuations in the number of eigenvalues of a GUE matrix that exceed a certain threshold, that are say, positive.

No exact evaluation of this was known until the 2012 work by the author and Forrester. Entropy and mutual information are among the most important quantities in classical and quantum information theory and are fundamental in the design and analysis of communications, signal processing and quantum systems. Similarly evaluations of low-order moments for the fluctuations in mutual information were not previously known. However both of these can be computed explicitly in terms of hypergeometric functions, primarily because of two reasons: the first is that their generating functions are tau-functions of a particular Painleve type and secondly that a "zeroth order" tau-function is a trivial function. The derivation of these results will be explained.

Student Combinatorics  
Monday, November 26, 2018, 4:00pm-5:00pm  
3866 East Hall  
(University of Michigan)  
TBA
Geometry & Physics  
Monday, November 26, 2018, 4:00pm-6:00pm  
4096 East Hall  
Thomas Walpuski (MSU)  
*Super-rigidity and Castelnuovo’s bound*

Castelnuovo’s bound is a very classical result in algebraic geometry. It asserts a sharp bound on the genus of a curve of degree d in n-dimensional projective space. It is an interesting question to ask whether analogues of Castelnuovo’s bound hold in almost complex geometry. There is a direct analogue in dimension four. In dimension at least eight genus bounds can be established for generic almost complex structures. These results leave open the case of dimension six.

Bryan and Panharipande introduced the notion of super-rigidity of an almost complex structure. They also speculated that this condition might hold for a generic almost complex structure (compatible with a fixed symplectic structure). It had been believed for a long time that super-rigidity will play an important role in the proof of the Gopakumar-Vafa conjecture. However, it turned that Ionel and Parker’s recent proof of this conjecture did not make use of it. Nevertheless, super-rigidity has important consequences. I will present one of these consequences, namely, a genus bound for index zero pseudo-holomorphic curves. This is joint work with Aleksander Doan and, heavily, relies on work by De Lellis, Spadaro, and Spolaor and ideas of Taubes’.

There has been a lot of progress towards establishing Bryan and Pandharipande’s super-rigidity conjecture in the work of Wendl. In fact, based on his ideas, Aleksander Doan and I have developed an abstract framework for equivariant transversality/Brill-Noether type questions. Wendl’s work shows that the super-rigidity conjecture holds provided generic real Cauchy-Riemann operators satisfy an easy to state analytic condition. I will explain what this condition means and discuss a few cases in which this condition (or versions of it) hold.

Student Geometry/Topology  
Tuesday, November 27, 2018, 3:00pm-4:00pm  
1866 East Hall  
Montek Gill (University of Michigan)  
*Solving Thurston’s hyperbolic gluing equations over commutative rings*

Given an ideally triangulated 3-manifold, Thurston introduced certain polynomial equations, the hyperbolic gluing equations, whose solutions can be used to construct hyperbolic structures on the 3-manifold. The solutions yield a developing map and a holonomy representation of the fundamental group into PSL(2,C). Feng Luo showed that if we solve the equations over an arbitrary commutative ring R, though we lose the geometry, we can still construct a holonomy representation into PGL(2,R). This led him to a conjecture that all compact 3-manifold groups are "residually PSL(2)-finite", a strengthening of residual finiteness. I'll discuss all of this, together with a counterexample to the conjecture that I, together with Stephan Tillmann and Stefan Friedl, found a few years ago.
Colloquium Series  
**Tuesday, November 27, 2018, 4:00pm-5:00pm**  
*1360 East Hall*  
**Andrei Negut (MIT)**  
*Braids and sheaves: a geometric incarnation of Khovanov-Rozansky homology*

In this talk, I will survey recent work on the connection between various categorical knot invariants (e.g. Khovanov's construction via Soergel bimodules) to categories of coherent sheaves on Hilbert schemes of points on the plane. I will emphasize the conjectural framework proposed by Gorsky, Rasmussen and myself, as well as the related matrix factorization version due to Oblomkov and Rozansky.

Student Arithmetic  
**Wednesday, November 28, 2018, 3:00pm-3:50pm**  
*4096 East Hall*  
**Jonathan Gerhard (University of Michigan)**  
*An Introduction to Arithmetic Statistics*

My plan for this talk is essentially to showcase a lot of really interesting questions in Arithmetic Statistics, without diving too deep into the details. A main goal of this field is to enumerate number-theoretic objects like primes, number fields, and elliptic curves. In many cases, enumerate is taken to be probabilistic - what's the probability the class group of a number field is cyclic? What's the density of twin primes in the set of primes? How many elliptic curves have rank 0? Rank 1? Questions like these have lead to some incredibly important results in modern mathematics, a few of which include the Cohen-Lenstra heuristics and the Birch and Swinnerton-Dyer conjecture.
Financial/Actuarial Mathematics

Wednesday, November 28, 2018, 4:00pm-5:00pm
1360 East Hall

Sebastian Hermann (UM)

Inventory Management for High-Frequency Trading with Imperfect Competition

We study Nash equilibria for inventory-averse high-frequency traders (HFTs), who trade to exploit information about future price changes. For discrete trading rounds, the HFTs’ optimal trading strategies and their equilibrium price impact are described by a system of nonlinear equations; explicit solutions obtain around the continuous-time limit. Unlike in the risk-neutral case, the optimal inventories become mean-reverting and vanish as the number of trading rounds becomes large. In contrast, the HFTs' risk-adjusted profits and the equilibrium price impact converge to their risk-neutral counterparts. Compared to a social-planner solution for cooperative HFTs, Nash competition leads to excess trading, so that marginal transaction taxes in fact decrease market liquidity. (Joint work with Johannes Muhle-Karbe, Dapeng Shang, and Chen Yang.)

RTG Seminar on Geometry, Dynamics and Topology

Wednesday, November 28, 2018, 4:00pm-5:30pm
3866 East Hall

Chris Leininger (UIUC)

Polygonal billiards, Liouville currents, and rigidity

A particle bouncing around inside a Euclidean polygon gives rise to a biinfinite “bounce sequence” (or "cutting sequence") recording the (labeled) sides encountered by the particle. In this talk, I will describe recent work with Duchin, Erlandsson, and Sadanand, in which we prove that the set of all bounce sequences---the "bounce spectrum"---essentially determines the shape of the polygon. This is consequence of our main result about Liouville currents on surfaces associated to nonpositively curved Euclidean cone metrics. In the talk I will explain the objects mentioned above, how they relate to each other, and give some idea of the proof of the main theorem.

Algebraic Geometry

Wednesday, November 28, 2018, 4:00pm-5:20pm
4096 East Hall

Andrei Negut (MIT)

Algebraic cycles on Hilb(K3) and the Virasoro algebra

We will present a geometric representation theory proof of a mild version of the Beauville-Voisin conjecture for Hilbert schemes of K3 surfaces, namely the injectivity of the cycle map on the subring of Chow generated by tautological classes. To this end, we lift formulas of Lehn and Li-Qin-Wang from cohomology to Chow groups, and use them to quickly solve the problem by invoking the irreducibility criteria of Virasoro algebra modules. This is joint work with Davesh Maulik.
Equivariant stable homotopy theory takes into account the action of a compact Lie group. This subject has modern applications in the Hill-Hopkins-Ravenel proof of the Kervaire invariant theorem and algebraic K-theory. In this talk I will try to explain the foundations in a more modern way. Topics include construction of the equivariant stable category, and its structures.

The twisted rabbit problem is a celebrated problem in complex dynamics. Work of Thurston proves that up to equivalence, there are exactly three branched coverings of the sphere to itself satisfying certain conditions. When one of these branched coverings is modified by a mapping class, a map equivalent to one of the three coverings results. Which one?

After remaining open for 25 years, this problem was solved by Bartholdi-Nekyrashevych using iterated monodromy groups. In joint work with Belk, Lanier, and Margalit, we present an alternate topological solution that allows for generalization. In this talk, I will work through new examples that were uncovered by our work.

Hochster and Huneke introduced the gamma construction to prove that test elements (in the sense of tight closure) exist on all rings essentially of finite type over excellent local rings of characteristic $p > 0$. Since then, the gamma construction has become a useful tool in tight closure theory when studying rings for which the Frobenius map is not module-finite. We present some new results about the gamma construction, which we use to study openness of F-singularities in the non-F-finite setting. We then use a scheme-theoretic version of these results to study asymptotic invariants of line bundles over arbitrary fields.
A well-known problem in computational number theory is to compute the probability that a given finite abelian $l$-group arises as the $l$-torsion part of the class group of a random quadratic imaginary field, where $l$ is an odd prime number. Cohen and Lenstra conjectured an explicit probability based on a heuristics that such class groups are uniformly distributed among finite abelian groups with the probability inversely proportional to the orders of their automorphism groups. In this talk, we will discuss a non-trivial characterization due to Ellenberg, Venkatesh, and Westerland of the probability measure given by Cohen and Lenstra. This will also let us discuss the status of an analogous problem when we replace the spectrum of the integers with the projective line over a finite field, which is due to Ellenberg, Venkatesh, and Westerland.

The minimal prerequisite for this talk is Math 116.

For self-adjoint operators, it implies that such an operator’s resolvent is controlled by the distance of the spectral parameter from the spectrum. However, in the non-self-adjoint case this property can fail quite drastically. It is possible for the resolvent of such operators to grow quite large far away from the spectrum. In this talk we will look at some of the ways in which it is possible to control the size of resolvents for Schrödinger operators with complex potentials in the semiclassical limit and some implications of such estimates.
The mechanical processes that deform pack ice at high latitudes are governed by thin plate theory. One can show that the associated patterns are associated with the elastic failures. Whilst we understand that such failures underlie the constitutive law of the aggregate as embodied in the momentum equation deriving such from thin plate theory has been an intransient task. On the other hand, we can derive a generalized description of ice thickness distribution (the pdf of ice thickness) using concepts from stochastic dynamics. The full problem can be forced by atmospheric and oceanic fluxes and produce the observed climatology of the ice pack through the numerical solution of a single Fokker-Planck equation (FPE). As such, it provides a far simpler framework for climate modeling than does the typical approach. Further insight is provided by analysis of the FPE. For example, it can be cast in terms of a Bessel-like process described by an FPE with a logarithmic potential and solved by seeking solutions through an expansion into a complete set of eigenfunctions. The associated imaginary-time Schrödinger equation exhibits a mix of discrete and continuous eigenvalue spectra, corresponding to the quantum Coulomb potential describing the bound states of the hydrogen atom. We demonstrate this technique by solving the Brownian motion problem and the Bessel process both with a constant negative drift.

Dilation surfaces are geometric structures that are in a way a generalization of translation surfaces. One way to define a dilation surface is as a collection of polygons with sides identified by translations and dilations by positive real factors, whereas translation surfaces only allow side identifications by translations. This small generalization is enough to introduce interesting new dynamical behaviors on dilation surfaces that do not occur for translation surfaces. In this talk, we will introduce dilation surfaces through the lens of pseudo-Anosov maps and fibered 3-manifolds, survey similarities and differences between dilation surfaces and translation surfaces, and end by discussing some questions about the Teichmüller dynamics of dilation surfaces.
Combinatorics  
Friday, November 30, 2018, 3:00pm-4:00pm  
2866 East Hall  
Greg Muller (University of Oklahoma)  
Linear recurrence relations with periodic solutions

We consider the elementary problem of when every solution to a linear recurrence relation is periodic (or more generally, quasiperiodic). We give three (somewhat surprising) characterizations of these recurrences, which all generalize known results about `friezes'. This leads to a generalization of friezes for any juggling pattern.

Time permitting, I will discuss how such recurrences may be parametrized by the faces of certain planar bipartite graphs via an analog of Postnikov's `boundary measurement map'. Conjecturally, this endows the space of such recurrences with a Y-type cluster structure that is mirror dual to the X-type cluster structure on an associated positroid variety.

Junior Colloquium Series  
Friday, November 30, 2018, 4:00pm-5:00pm  
3088 East Hall  
Zaher Hani (University of Michigan)  
Nonlinear Waves: statistical mechanics and turbulence

Nonlinear Dispersive equations are a class of partial differential equations that model "wavy" phenomena in science and engineering. The mathematical understanding of such equations has featured a rather beautiful combination of tools and ideas from harmonic analysis, dynamical systems, probability, and even analytic number theory. We will discuss briefly how these tools show up in the study of such equations, particularly in the attempt to develop the theory of statistical mechanics for "wavy systems". Such a theory is the theoretical framework to understand various turbulence phenomena that arise in oceans, plasma, and optics.

Student Machine Learning  
Friday, November 30, 2018, 5:00pm-6:00pm  
4088 East Hall  
Alexandros Georgakopoulos (University of Michigan)  
A Variance Minimization Criterion to Active Learning on Graphs

In this talk, we give a short overview of the problem of active learning over the vertices of a graph. After considering the problem with the common graph smoothness assumption of a Gaussian random field model, we present the Variance Minimization algorithm developed by Ji and Han.