### Monday, September 30, 2019

11:00am-12:00pm **Representation Stability** -- Andrew Snowden (UM) *Ideals stable under the infinite symmetric group* -- 3866 East Hall

3:00pm-4:00pm **Student Combinatorics** -- Gilyoung Cheong () *Random characteristic polynomials converge to random permutations* -- 3096 East Hall

3:00pm-4:00pm **Student Dynamics** -- Karen Butt (UM) *Boundary Rigidity* -- 3866 East Hall

4:00pm-5:00pm **Complex Analysis, Dynamics and Geometry** -- Vefa Goksel (UWisconsin) *Misiurewicz polynomials and irreducibility* -- 3866 East Hall

4:00pm-5:00pm **Integrable Systems and Random Matrix Theory** -- Asad Lodhia (University of Michigan) *Covariance Kernel for Half-Heavy Random Matrix Eigenvalues* -- 1866 East Hall

4:00pm-6:00pm **Geometry & Physics** -- Yingchun Zhang (UM) *Open Gromov-Witten Theory of Toric Calabi-Yau 3-folds and Quasi-Siegel Modular Forms* -- 4096 East Hall

4:00pm-5:00pm **Student AIM Seminar** -- Rishi Sonthalia (University of Michigan) *Metric Constrained Problems* -- B737 East Hall

4:00pm-5:00pm **Student Algebraic Geometry** -- James Hotchkiss (UM) *Stable vector bundles on curves* -- B745 East Hall

5:00pm-6:00pm **Student Analysis** -- Malavika Mukundan (University of Michigan) *The Invariant Subspace Problem* -- 2866 East Hall

5:30pm-6:30pm **Chromatic Homotopy Theory** -- Bogdan Zavyalov (Stanford/UM) *Lazard's theorem.* -- 3088 East Hall

### Tuesday, October 01, 2019

11:30am-1:00pm **Teaching Mathematics** -- LCIT Discussion () *Learning Community on Inclusive Teaching Discussion* -- 4866 East Hall

3:00pm-3:50pm **Student Commutative Algebra** -- Zhou Fang (University of Michigan Ann Arbor) *Basic facts of tight closure theory* -- 4088 East Hall

3:00pm-4:00pm **Student Geometry/Topology** -- Bradley Zykoski (UM) *Retracting the moduli space of curves* -- 3866 East Hall

4:00pm-5:00pm **Colloquium Series** -- Alex Perry (IAS, Princeton) *Derived categories of cubic fourfolds and their geometric applications* -- 1360 East Hall

### Wednesday, October 02, 2019

3:00pm-4:00pm **Student Homotopy Theory** -- Benjamin Riley (University of Michigan) *A Spectrum of Spectra* -- 1372 East Hall

3:00pm-4:00pm **Student Arithmetic** -- Andy Gordon (UM) *Integer Binary Quadratic Forms* -- 3866 East Hall

4:00pm-5:00pm **Financial/Actuarial Mathematics** -- Justin Sirignano (UIUC) *Deep Learning: Applications and Asymptotics* -- 1360 East Hall

4:00pm-5:30pm **Algebraic Geometry** -- Alex Perry (IAS) *The integral Hodge conjecture for CY2 categories* -- 4096 East Hall

4:00pm-5:30pm **RTG Seminar on Geometry, Dynamics and Topology** -- Mitul Islam (U Michigan) *Convex co-compact actions of relatively hyperbolic groups* -- 3866 East Hall
### Thursday, October 03, 2019

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<td>3:00pm-4:00pm</td>
<td><strong>Topology</strong> -- Sayantan Khan (University of Michigan) <em>A tour through the proof of Margulis Superrigidity</em></td>
<td>3866 East Hall</td>
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<td>3:00pm-4:00pm</td>
<td><strong>Commutative Algebra</strong> -- Mel Hochster (University of Michigan) <em>An Overview of Tight Closure Theory II</em></td>
<td>4088 East Hall</td>
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<td>4:00pm-5:00pm</td>
<td><strong>Differential Equations</strong> -- Bjoern Bringmann (UCLA) <em>Almost sure scattering for the energy-critical nonlinear wave equation</em></td>
<td>4088 East Hall</td>
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<td>4:00pm-5:30pm</td>
<td><strong>Arithmetic Geometry Learning</strong> -- Andrew Snowden (UM) <em>Locally compact abelian groups</em></td>
<td>4096 East Hall</td>
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### Friday, October 04, 2019

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<th>Time</th>
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<td>2:30pm-4:00pm</td>
<td><strong>Quant Program Practitioner</strong> -- Dimitri Bianco (Santander Bank) <em>Careers in Quantitative Finance</em></td>
<td>B844 East Hall</td>
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<td>3:00pm-4:00pm</td>
<td><strong>Applied Interdisciplinary Mathematics (AIM)</strong> -- Giovanni Russo (University of Catania and University of Michigan) <em>Multi-scale numerical modeling of sorption kinetics</em></td>
<td>1084 East Hall</td>
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<tr>
<td>3:00pm-4:00pm</td>
<td><strong>Combinatorics</strong> -- David Galvin (University of Notre Dame) <em>Total non-negativity of some combinatorial matrices</em></td>
<td>4096 East Hall</td>
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<tr>
<td>4:00pm-4:50pm</td>
<td><strong>Geometry</strong> -- Rita Gitik (UM) <em>On Geodesic Triangles in the Hyperbolic Plane</em></td>
<td>3866 East Hall</td>
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<tr>
<td>4:00pm-5:00pm</td>
<td><strong>Junior Colloquium Series</strong> -- Peter Miller (University of Michigan) <em>Solitons, Integrable Systems, and Asymptotics (Research at Michigan Series)</em></td>
<td>3088 East Hall</td>
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<tr>
<td>4:00pm-5:30pm</td>
<td><strong>Preprint Algebraic Geometry</strong> -- Shubhodip Mondal (UM) <em>A stacky approach to crystals, following Drinfeld</em></td>
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Representation Stability  
**Monday, September 30, 2019, 11:00am-12:00pm**  
**3866 East Hall**  
Andrew Snowden (UM)  
*Ideals stable under the infinite symmetric group*  

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**Student Combinatorics**  
**Monday, September 30, 2019, 3:00pm-4:00pm**  
**3096 East Hall**  
Gilyoung Cheong ()  
*Random characteristic polynomials converge to random permutations*  

We extend an observation due to Richard Stong to see that given an $n \times n$ random matrix over the finite field of $p$ elements, as $p$ goes to infinity, its characteristic polynomial "converges" to a random permutation in the symmetric group of $n$ letters. We will see that this simple result has the following interesting arithmetic consequences:  

1. Some distribution of cokernels of $n \times n$ $p$-adic Haar-random matrices as $p$ and $n$ go to infinity;  
2. A matrix version of a theorem of Landau that estimates the number of prime factors of a large integer.  

This is joint work with Hayan Nam and Myungjun Yu.  

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**Student Dynamics**  
**Monday, September 30, 2019, 3:00pm-4:00pm**  
**3866 East Hall**  
Karen Butt (UM)  
*Boundary Rigidity*  

Given a smooth Riemannian manifold with boundary $M$, we get a distance function on the boundary given by the length of the shortest geodesic in $M$ joining two given boundary points. We can ask to what extent this boundary distance function determines the metric on the whole space. In the case of negatively curved surfaces (with boundary), it is known that the boundary distance function determines the surface up to isometry. In this talk, I will outline Otal's proof of this result. If time permits, I will discuss the relation between the boundary rigidity problem and the marked length spectrum rigidity problem. No prior background in dynamics or Riemannian geometry will be assumed.
Consider the unicritical polynomial family $f_{c}(x)=x^d+c$. The $c$-values for which the polynomial has a strictly preperiodic critical orbit are called Misiurewicz parameters. All Misiurewicz parameters are algebraic integers. Suppose that the Misiurewicz parameters $c_0$ and $c_0$ are such that the polynomials $f_{c_0}$ and $f_{c_1}$ have the same orbit type. One classical question is whether $c_0$ and $c_1$ are Galois conjugate. I will talk about some partial results related to this question.

Abstract: Matrices with heavy-tailed entries are extremely hard to study using the moment method and also fairly often lack explicit formulas for the eigenvalue density. While results are known on both the limiting spectral measure and the limiting covariance, they are often expressed as coupled fixed point equations for the Stieltjes transform which are difficult to analyze. In our joint work with Anna Maltsev, we obtain some insight on the fluctuations of certain linear statistics of eigenvalues of what are called "half-heavy" random matrices. These are random matrices with 2 finite moments (which means they satisfy the semicircle law) but no greater (which means they do not satisfy edge universality). As it turns out the formula can be seen to have some dependence on the intensity measure of a Poisson Process corresponding to the law of the largest eigenvalues of the matrix.
Geometry & Physics  
Monday, September 30, 2019, 4:00pm-6:00pm  
4096 East Hall  
Yingchun Zhang (UM)  
*Open Gromov-Witten Theory of Toric Calabi-Yau 3-folds and Quasi-Siegel Modular Forms*

Open Gromov-Witten theory is about counting curves with fixed genus and boundaries. For the open Gromov-Witten theory of toric Calabi-Yau 3-folds, there is a well-established mirror symmetry called BKMP remodeling conjecture. Under the mirror map, the generating series of open Gromov-Witten invariants corresponds to the B-model invariant constructed by topological recursion on the mirror curve. Then the modularity of open-closed Gromov-Witten theory can be investigated via the modularity of B-model invariants.

For toric Calabi-Yau 3-fold whose mirror curve is of genus 1, we have already proved that the generating series of open Gromov-Witten invariants is meromorphic quasi-Jacobi form. Our recent result proves that when the mirror curve is of genus 2, the generating series of closed Gromov-Witten invariants is a quasi-Siegel modular form, and the generating series of open-Gromov-Witten invariants is pull-back of quasi-Siegel Jacobi form via Abel-Jacobi map.

In this talk, I will briefly recall the open Gromov-Witten theory and the mirror symmetry, give the construction of the rings of quasi-Siegel modular forms and quasi-Siegel Jacobi forms, and give the idea to gain the modularity of open-closed Gromov-Witten theory. This is joint work with Yongbin Ruan and Jie Zhou.

Student AIM Seminar  
Monday, September 30, 2019, 4:00pm-5:00pm  
B737 East Hall  
Rishi Sonthalia (University of Michigan)  
*Metric Constrained Problems*

Many modern data analysis algorithms either assume or are considerably more efficient if the distances between the data points satisfy a metric. These algorithms include metric learning, clustering, and dimension reduction. As real data sets are noisy, distances often fail to satisfy a metric. However learning good metrics is challenging due to the large number of constraints. In this talk I will present some metric constrained problems as well some new advances in methods used to learn these metrics and their application to machine learning.
A famous theorem of Grothendieck states that every vector bundle on the projective line splits into a direct sum of line bundles; hence, a vector bundle on the projective line is completely determined (up to isomorphism) by a finite set of integers. On curves of higher genus, however, the situation is more complicated: Vector bundles are no longer determined by a discrete set of data. Instead, one has to ask whether isomorphism classes of vector bundles can be parameterized by an algebraic variety.

Unfortunately, the answer is no. But it turns out that if one focuses on a smaller class of stable vector bundles, then one may construct a smooth quasi-projective variety whose points are in bijection with isomorphism classes of stable vector bundles (and much, much more).

After reviewing the situations in genus zero and one, I will present an introduction to stable vector bundles on curves of higher genus. I will be assuming little background aside from some familiarity with the languages of vector bundles and algebraic curves.

Given a Banach space and a bounded linear operator on it, the invariant subspace problem refers to the existence of a proper subspace invariant under the operator. We discuss a history of this problem and discuss a solution in the case of subalgebras of bounded operators on a Banach space that contain compact operators. The highlight is on the use of fixed point theorems for the same.

Based on Lecture 2 and Lecture 3 from http://www.math.harvard.edu/~lurie/252x.html.
Teaching Mathematics  
Tuesday, October 01, 2019, 11:30am-1:00pm  
4866 East Hall  
LCIT Discussion ()  
Learning Community on Inclusive Teaching Discussion

Details about the Learning Community may be found at  

Student Commutative Algebra  
Tuesday, October 01, 2019, 3:00pm-3:50pm  
4088 East Hall  
Zhou Fang (University of Michigan Ann Arbor)  
Basic facts of tight closure theory

This talk will first introduce basic notions and facts about tight closure of module. Then we will prove  
Briancon-Skoda Theorem in char p. Finally, this talk will cover general facts about F-finite, F-regular, F-split and  
F-rational rings.

Student Geometry/Topology  
Tuesday, October 01, 2019, 3:00pm-4:00pm  
3866 East Hall  
Bradley Żykoski (UM)  
Retracting the moduli space of curves

In this talk I will present Harer's mapping-class-group-equivariant spine of the Teichmueller space of a  
punctured surface. From this it follows that the rational Betti numbers of the moduli space of the surface start to  
vanish in degrees far lower than the topological dimension.
Colloquium Series  
Tuesday, October 01, 2019, 4:00pm-5:00pm  
1360 East Hall  
Alex Perry (IAS, Princeton)  
*Derived categories of cubic fourfolds and their geometric applications*

A fundamental problem in algebraic geometry is to determine whether a given algebraic variety is birational to projective space. This is most prominently open for cubic fourfolds, i.e. hypersurfaces defined by a cubic polynomial in a five-dimensional projective space. Eleven years ago, Kuznetsov suggested an approach to this problem using the derived category of coherent sheaves. I will explain recent applications of this perspective to fundamental questions in hyperkahler geometry and Hodge theory, which in turn shed light on the original question about cubic fourfolds.

Student Homotopy Theory  
Wednesday, October 02, 2019, 3:00pm-4:00pm  
1372 East Hall  
Benjamin Riley (University of Michigan)  
*A Spectrum of Spectra*

Spectra are important tools in algebraic topology, generalizing many notions familiar to spaces. In particular, the data carried by a spectrum is equivalent (up to homotopy) to the data of a generalized (co)homology theory. This talk will focus on qualifying this result, by providing several examples familiar and potentially unfamiliar to the audience.

Student Arithmetic  
Wednesday, October 02, 2019, 3:00pm-4:00pm  
3866 East Hall  
Andy Gordon (UM)  
*Integer Binary Quadratic Forms*

It is not too hard to show that if two integers $m$ and $n$ can both be written as a sum of two squares, so can $mn$. This is a consequence of a more general result, there is a natural group structure on the set of $\text{SL}(2,\mathbb{Z})$ equivalence classes of integer binary quadratic forms of a fixed discriminant. In this talk we will look at some ways of understanding this structure and applications.
Deep learning has revolutionized image, text, and speech recognition. Motivated by this success, there is growing interest in developing deep learning methods for financial applications. We will present some of our recent results in this area. In the second part of the seminar, we will study single-layer neural networks with the Xavier initialization in the asymptotic regime of large numbers of hidden units and large numbers of stochastic gradient descent training steps. We prove the neural network converges in distribution to a random ODE with a Gaussian distribution using mean field analysis. Although the pre-limit problem of optimizing a neural network is non-convex (and therefore the neural network may converge to a local minimum), the limit equation minimizes a (quadratic) convex objective function and therefore converges to a global minimum. Furthermore, under reasonable assumptions, the matrix in the limiting quadratic objective function is positive definite and thus the neural network (in the limit) will converge to a global minimum with zero loss on the training set.

I will formulate a version of the integral Hodge conjecture for categories, discuss its proof for categories which are suitably deformation equivalent to the derived category of a K3 or abelian surface, and explain how this implies new cases of the usual integral Hodge conjecture for varieties.

In 2017, Danciger-Gue'ritaud-Kassel (DGK) introduced a `higher-rank' generalization of Kleinian groups using a notion of convex co-compactness for groups acting on Hilbert geometries (properly convex subsets of RP^n). DGK (and independently, Zimmer) proved that for hyperbolic groups, admitting such a convex co-compact action is equivalent to the "convex-core" being strictly convex. In their paper, DGK had asked whether an analogous result holds for relatively hyperbolic groups. We provide a complete answer to this question by introducing the notion of Hilbert geometries with isolated simplices. This is joint work with Andrew Zimmer.
Topology
Thursday, October 03, 2019, 3:00pm-4:00pm
3866 East Hall
Sayantan Khan (University of Michigan)
A tour through the proof of Margulis Superrigidity

Margulis’ Superrigidity theorem tells us that for a higher rank semisimple Lie group G, any representation of a lattice extends to a continuous representation of G (under reasonably mild conditions). In this talk, we’ll go through a proof of this fact, and along the way see how this proof combines ideas from Lie theory, dynamics, and random walks on groups. In particular, we’ll see how a stationary measure on G/P is constructed, and combine that with measure proximality to prove Margulis Superrigidity.

Commutative Algebra
Thursday, October 03, 2019, 3:00pm-4:00pm
4088 East Hall
Mel Hochster (University of Michigan)
An Overview of Tight Closure Theory II

This is the second of two talks. The abstract for both is as follows. Tight closure will be defined both for Noetherian rings of characteristic $p > 0$ and equal characteristic 0. A number of characterizations will be given, along with a discussion of some basic properties. The theory will be applied to give easy proofs of some substantial theorems. A number of open questions will be discussed.

Differential Equations
Thursday, October 03, 2019, 4:00pm-5:00pm
4088 East Hall
Bjoern Bringmann (UCLA)
Almost sure scattering for the energy-critical nonlinear wave equation

We will discuss the defocusing energy-critical nonlinear wave equation. For deterministic and smooth initial data, it is widely known that the solutions scatter, i.e., they asymptotically behave like solutions to the linear wave equation. In this talk, we will show that this scattering behavior persists under random and rough perturbations of the initial data. As part of the argument, we will discuss techniques from restriction theory, such as wave packet decompositions and Bourgain’s bush argument.

Arithmetic Geometry Learning
Thursday, October 03, 2019, 4:00pm-5:30pm
4096 East Hall
Andrew Snowden (UM)
Locally compact abelian groups
Quant Program Practitioner  
Friday, October 04, 2019, 2:30pm-4:00pm  
B844 East Hall  
Dimitri Bianco (Santander Bank)  
*Careers in Quantitative Finance*

Dimitri Bianco is a U-M alum, risk manager, and Youtuber currently working as an associate director at Santander Bank. He will speak about the many career paths in quantitative finance and how students can pursue them.

The event will begin at 2:30 with an informal conversation about current Quant students' experiences in the program. The formal presentation will begin at 2:45.
The trapping of diffusing particles by either a single or a distribution of moving traps is an interesting topic that has been employed to model a variety of different real problems in chemistry, physics and biology. Here we study the dynamics of diffusing particles in a domain with an oscillating bubble. Laboratory experiments provide evidence of a non monotone behavior in time of the concentration of particles by a detector located behind the bubble, under suitable experimental condition. A comprehensive explanation of the phenomenon is not yet fully available. The particles are attracted and trapped near the surface of the bubble. The basic mathematical model is a drift-diffusion model, where the particles diffuse and feel the potential of the bubble when they are near its surface. A tentative explanation of the mechanism is based on two-carrier dynamics.

The numerical simulation of the system presents two multi-scale challenges. One is spatial: the range of the bubble potential is confined within a few microns at the bubble surface, while the bubble radius is of the order of a millimeter, so a fully resolved solution would be too expensive. The second challenge is on the time scale: the bubble oscillates with a frequency of the order of 100 Hz, while the diffusion time scale is of the order of 1000 seconds, this requiring at least one million time steps to fully resolve the problem in time.

A reduced model is derived to solve the multi-scale problem in space for the single carrier dynamics: the interaction with the bubble is modeled as a very thin layer, with a particle surface density proportional to the local density in the bulk, near the bubble. In the rest of the domain the particle density satisfies just a diffusion equation, with suitable boundary conditions on the bubble, deduced from conservation properties.

The model is carefully tested on problems in 1D, 2D planar and 3D axis-symmetric geometry. The equation is discretized on a regular Cartesian mesh, using a ghost-point approach, and solved by Crank-Nicolson scheme. The implicit step is efficiently solved by a suitably adapted multi-grid method. The amplitude of the bubble oscillations is small compared to the bubble radius. We take advantage of this fact by replacing the time dependent position by a suitable time dependent velocity at the bubble surface. Because of the low Reynolds number, the velocity distribution is computed by Stokes approximation. The multi-scale challenge in time, as well as the multi-scale model for multi-carrier dynamics are still under investigation.
Combinatorics
Friday, October 04, 2019, 3:00pm-4:00pm
4096 East Hall
David Galvin (University of Notre Dame)
Total non-negativity of some combinatorial matrices

Many combinatorial matrices --- such as those of binomial coefficients, Stirling numbers of both kinds, and Lah numbers --- are known to be totally non-negative, meaning that all minors (determinants of square submatrices) are non-negative.

The examples noted above can be placed in a common framework: for each one there is a non-decreasing sequence \((a_1, a_2, \ldots)\), and a sequence \((e_1, e_2, \ldots)\), such that the \((m,k)\)-entry of the matrix is the coefficient of the polynomial \((x-a_1)...(x-a_m)\) in the expansion of \((x-e_1)...(x-e_m)\) as a linear combination of the polynomials \(1, x-a_1, \ldots, (x-a_1)...(x-a_m)\).

We consider this general framework. For a non-decreasing sequence \(a_1, a_2, \ldots\) we establish necessary and sufficient conditions on the sequence \(e_1, e_2, \ldots\) for the corresponding matrix to be totally non-negative.

This is joint work with Adrian Pacurar, Notre Dame.

Geometry
Friday, October 04, 2019, 4:00pm-4:50pm
3866 East Hall
Rita Gitik (UM)
On Geodesic Triangles in the Hyperbolic Plane

Let \(M\) be an orientable hyperbolic surface without boundary and let \(c\) be a closed geodesic in \(M\). We prove that any side of any triangle formed by distinct lifts of \(c\) in the hyperbolic plane is shorter than \(c\).

The talk will be presented for advanced undergraduate and beginning graduate students.

Junior Colloquium Series
Friday, October 04, 2019, 4:00pm-5:00pm
3088 East Hall
Peter Miller (University of Michigan)
Solitons, Integrable Systems, and Asymptotics (Research at Michigan Series)

This talk is a gentle introduction to soliton theory and integrable systems, and the role played in practice by asymptotic analysis. We will discuss some interesting history of the subject and also highlight some contributions made by Michigan PhD students.
Preprint Algebraic Geometry
Friday, October 04, 2019, 4:00pm-5:30pm
2866 East Hall
Shubhodip Mondal (UM)
A stacky approach to crystals, following Drinfeld

https://arxiv.org/abs/1810.11853