### Monday, November 12, 2018

<table>
<thead>
<tr>
<th>Time</th>
<th>Seminar</th>
<th>Location</th>
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<tbody>
<tr>
<td>12:00pm-12:50pm</td>
<td><strong>Mathematical Biology</strong> -- Len Sander (Physics &amp; Complex Systems, University of Michigan) <em>Durotaxis, Random Walkers, and the Electric Telegraph</em></td>
<td>335 West Hall</td>
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<tr>
<td>3:00pm-4:00pm</td>
<td><strong>Student Dynamics</strong> -- Benjamin Krakoff (University of Michigan) <em>Rational Maps and Julia Sets</em></td>
<td>1060 East Hall</td>
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<tr>
<td>4:00pm-5:00pm</td>
<td><strong>Complex Analysis, Dynamics and Geometry</strong> -- Tom Sharland (URI) <em>Matings of cubic polynomials with a fixed critical point</em></td>
<td>3088 East Hall</td>
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<td>4:00pm-5:20pm</td>
<td><strong>Group, Lie and Number Theory</strong> -- Alison Miller (Harvard) <em>Sp_{2g}-orbits of quadratic forms</em></td>
<td>4088 East Hall</td>
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<td>4:00pm-5:00pm</td>
<td><strong>Student Combinatorics</strong> -- Alana Huszar (University of Michigan) <em>Quiver representations</em></td>
<td>3866 East Hall</td>
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<td>4:00pm-6:00pm</td>
<td><strong>Integrable Systems and Random Matrix Theory</strong> -- Zachary Hamaker (University of Michigan) <em>Wronskian Appell polynomials</em></td>
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<td>4:00pm-5:00pm</td>
<td><strong>Geometry &amp; Physics</strong> -- Jingchen Niu (University of Arizona) <em>Modular Resolution of the Moduli Space of Genus 2 Stable Maps</em></td>
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<td>11:30am-1:00pm</td>
<td><strong>Teaching Mathematics</strong> -- Discussion () <em>Learning Community on Inclusive Teaching, F18 Discussion 2</em></td>
<td>4866 East Hall</td>
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<td>3:00pm-4:00pm</td>
<td><strong>Student Geometry/Topology</strong> -- Karen Butt (University of Michigan) <em>The Three Types of Mapping Classes</em></td>
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<td>4:00pm-5:00pm</td>
<td><strong>Colloquium Series</strong> -- Dan Margalit (George Institute of Technology) <em>Algebraic, Geometric, and Dynamical Aspects of Surfaces</em></td>
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<td><strong>Student Arithmetic</strong> -- Patrick Kelley (University of Michigan) <em>Introduction to Arakelov Theory</em></td>
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<td>4:00pm-5:00pm</td>
<td><strong>Financial/Actuarial Mathematics</strong> -- Xin Zhang (UM) <em>Transport plans with domain constraints</em></td>
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<td>4:00pm-5:00pm</td>
<td><strong>Analysis/Probability</strong> -- Alexander Volberg (Michigan State University) <em>Improving constant in Poncare inequality on Hamming cube in L^1 metric.</em></td>
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<td><strong>RTG Seminar on Geometry, Dynamics and Topology</strong> -- Richard Canary (U Michigan) <em>Dynamics and the Hitchin component</em></td>
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### Thursday, November 15, 2018

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<tr>
<td>1:00pm-2:30pm</td>
<td><strong>Student Homotopy Theory</strong> -- Jack Carlisle (University of Michigan) <em>Vector Bundles and Characteristic Classes</em></td>
<td>2866 East Hall</td>
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<tr>
<td>3:00pm-4:00pm</td>
<td><strong>Commutative Algebra</strong> -- d Schwede (University of Utah) <em>A Kunz-type characterization of regular rings via alterations</em></td>
<td>4088 East Hall</td>
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<tr>
<td>4:00pm-5:00pm</td>
<td><strong>Student Algebraic Geometry</strong> -- Alapan Mukhopadhyay () <em>Toric varieties</em></td>
<td>3866 East Hall</td>
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<td>3:00pm-4:00pm</td>
<td><strong>Applied Interdisciplinary Mathematics (AIM)</strong> -- Katie Storey (University of Michigan) <em>Stochastic modeling of mutant clone propagation during carcinogenesis</em> -- 1084 East Hall</td>
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<tr>
<td>3:00pm-4:00pm</td>
<td><strong>Geometry</strong> -- Paul Apisa (Yale) <em>Using flat geometry to understand the dynamics of every point - Hausdorff dimension, divergence, and Teichmueller geodesic flow</em> -- 3866 East Hall</td>
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<td>3:00pm-4:00pm</td>
<td><strong>Combinatorics</strong> -- James Propp (University of Massachusetts, Lowell) <em>Dynamics from Posets</em> -- 2866 East Hall</td>
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<td>4:00pm-5:00pm</td>
<td><strong>Junior Colloquium Series</strong> -- Michael Von Korff (Curriculum Associates) <em>Fulfilling the Promise of Online Mathematics Instruction</em> -- 3088 East Hall</td>
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<tr>
<td>5:00pm-6:00pm</td>
<td><strong>Student Machine Learning</strong> -- Brian Chen (University of Michigan) <em>Recurrent Neural Networks</em> -- 4088 East Hall</td>
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Motile biological cells in tissue often display the phenomenon of durotaxis, i.e. they tend to move towards stiffer parts of substrate tissue. The mechanism for this behavior is not completely understood. We consider simplified models for durotaxis based on the classic persistent random walker scheme. We show that even a one-dimensional model of this type sheds interesting light on the classes of behavior cells might exhibit. Our results strongly indicate that cells must be able to sense the gradient of stiffness in order to show the effects observed in experiment. This is in contrast to the claims in recent publications that it is sufficient for cells to be more persistent in their motion on stiff substrates to show durotaxis: i.e. it would be enough to sense the value of the stiffness. We show that these cases give rise to extremely inefficient transport towards stiff regions. Gradient sensing is almost certainly the selected behavior.

We'll define the Julia set and Fatou set of a rational map, and show that it has lots of self-similarity.
Complex Analysis, Dynamics and Geometry  
**Monday, November 12, 2018, 4:00pm-5:00pm**  
3088 East Hall  
**Tom Sharland (URI)**  
*Matings of cubic polynomials with a fixed critical point*

It was shown by the work of Rees, Shishikura and Tan that if the mating of a pair of quadratic polynomials admits a Thurston obstruction, then this obstruction contains a Levy cycle. On the other hand, Shishikura and Tan showed that there exists a mating of cubic polynomials where the obstruction is not a Levy cycle. In this talk, we will consider matings of cubic polynomials each having a fixed critical point. We will show that if such a mating has an obstruction, then that obstruction contains a Levy cycle. Furthermore, we will discuss the combinatorics of the space of cubic polynomials with a fixed critical point, and a (conjectural) description of when two polynomials form an unobstructed mating. Along the way, we will draw parallels with the quadratic case.

Group, Lie and Number Theory  
**Monday, November 12, 2018, 4:00pm-5:20pm**  
4088 East Hall  
**Alison Miller (Harvard)**  
*Sp_{2g}-orbits of quadratic forms*

We will discuss the theory of Sp_{2g}-equivalence-classes of quadratic forms. These objects are a natural generalization of the classical theory of SL_2-equivalence classes of binary quadratic forms, as well as being a special case of orbits of the adjoint representation of a semisimple algebraic group. They also come up naturally as equivalence classes of Seifert matrices in knot theory.

We will use the geometry of numbers to count these objects asymptotically, weighted by regulator. We show that the number of Sp_{(2g)}(Z)-orbits of positive definite integral quadratic forms with invariant height \( \sim X^{g^2+1(2g+1)} \) is asymptotic to \( X^n \).

Student Combinatorics  
**Monday, November 12, 2018, 4:00pm-5:00pm**  
3866 East Hall  
**Alana Huszar (University of Michigan)**  
*Quiver representations*

A quiver is a directed graph; we can attach vector spaces to the vertices, and linear maps to the arrows to get a representation of the quiver. We'll discuss some first definitions with examples, leading to the construction of the "path algebra" associated to a quiver. We will also discuss indecomposable representations of quivers, and tame versus wild quivers.
Integrable Systems and Random Matrix Theory  
Monday, November 12, 2018, 4:00pm-5:00pm  
1866 East Hall  
Zachary Hamaker (University of Michigan)  
*Wronskian Appell polynomials*

I will discuss properties for Wronskians of Appell polynomials indexed by integer partitions. This family of polynomials appears in rational solutions of certain Painleve equations and in the study of exceptional orthogonal polynomials. Some results include computing their derivatives, their average with respect to Plancherel measure and several recurrence relations. One consequence is a proof of Bonneux and Stevens' conjecture that Wronskians of Hermite polynomials have integer coefficients. The proofs rely on a connection to the theory of symmetric functions, which will be discussed in detail. This is joint work with Niels Bonneux, John Stembridge and Marco Stevens.

Geometry & Physics  
Monday, November 12, 2018, 4:00pm-6:00pm  
4096 East Hall  
Jingchen Niu (University of Arizona)  
*Modular Resolution of the Moduli Space of Genus 2 Stable Maps*

We describe a (huge) sequence of modular blowups of the relative Picard stack of the Artin stack of pre-stable weighted genus 2 curves. The sequence of blowups diagonalizes certain tautological derived objects. This provides a resolution of the primary component of the moduli space of genus 2 stable maps to projective space and a partial desingularization of the same moduli space. Joint work with Yi Hu and Jun Li.

Teaching Mathematics  
Tuesday, November 13, 2018, 11:30am-1:00pm  
4866 East Hall  
Discussion ()  
*Learning Community on Inclusive Teaching, F18 Discussion 2*

In this session we will continue to discuss issues of Inclusivity in mathematics. Readings for discussion will be posted at [http://www.math.lsa.umich.edu/~glarose/dept/teaching/lcit.html](http://www.math.lsa.umich.edu/~glarose/dept/teaching/lcit.html).
Student Geometry/Topology
Tuesday, November 13, 2018, 3:00pm-4:00pm
1866 East Hall
Karen Butt (University of Michigan)
The Three Types of Mapping Classes

The mapping class group of a surface is the set of all orientation-preserving homeomorphisms of the surface up to homotopy. In this talk, we'll first see how the classification of hyperbolic isometries into elliptic, parabolic and hyperbolic elements gives us a classification of elements of the mapping class group of the torus. We will then state the Nielsen-Thurston classification theorem, which says that this trichotomy generalizes to higher genus. After giving many examples of the different types of mapping classes, we will sketch a proof of this classification theorem.

Colloquium Series
Tuesday, November 13, 2018, 4:00pm-5:00pm
1360 East Hall
Dan Margalit (George Institute of Technology)
Algebraic, Geometric, and Dynamical Aspects of Surfaces

To each homeomorphism of a surface we can associate a real number, called the entropy, which encodes the amount of mixing being effected. This number can be studied from topological, geometrical, dynamical, analytical, and algebraic viewpoints. We will start by explaining Thurston's beautiful insight for how to compute the optimal entropy within a homotopy class and explain a new, fast algorithm based on his ideas. We will also discuss some classical results and recent work concerning homeomorphisms with small entropy. One theme is that algebraic complexity and geometric complexity both imply dynamical complexity.
Student Arithmetic

Wednesday, November 14, 2018, 3:00pm-3:50pm
4096 East Hall

Patrick Kelley (University of Michigan)
Introduction to Arakelov Theory

A common approach in number theory is to attack arithmetic problems using geometric methods. For geometric problems over an algebraically closed field, a useful tool is intersection theory. Arakelov theory gives a version of intersection theory that is built for arithmetic applications. This talk will explore the motivation behind the theory as well as its basic definitions and properties. If time permits, then we can discuss a few major theorems and conjectures that utilize Arakelov theory.

This talk will only assume familiarity with valuations and the language of varieties. In particular, it will not require experience with schemes or intersection theory.

Financial/Actuarial Mathematics

Wednesday, November 14, 2018, 4:00pm-5:00pm
1360 East Hall

Xin Zhang (UM)
Transport plans with domain constraints

Let $\Omega$ be one of $X^{N+1}, C[0,1], D[0,1]$: product of Polish spaces, space of continuous functions from $[0,1]$ to $\mathbb{R}^d$, and space of RCLL (right-continuous with left limits) functions from $[0,1]$ to $\mathbb{R}^d$, respectively. We first consider the existence of a probability measure $P$ on $\Omega$ such that $P$ has the given marginals $\alpha$ and $\beta$ and its disintegration $P_x$ must be in some fixed $\Gamma(x) \subset \kP(\Omega)$, where $\kP(\Omega)$ is the set of probability measures on $\Omega$. The main application we have in mind is the martingale optimal transport problem when the martingales are assumed to have bounded volatility/quadratic variation.

We show that such probability measure exists if and only if the $\alpha$ average of the so-called $G$-expectation of bounded continuous functions with respect to the measures in $\Gamma$ is less than their $\beta$ average.

As a byproduct, we get a necessary and sufficient condition for the Skorokhod embedding for bounded stopping times. Second, we consider the optimal transport problem with constraints and obtain the Kantorovich duality. A corollary of this result is a monotonicity principle which gives us a geometric way of identifying the optimizer.

Joint work with Erhan Bayraktar and Zhou Zhou.
Analysis/Probability

Wednesday, November 14, 2018, 4:00pm-5:00pm
2866 East Hall

Alexander Volberg (Michigan State University)

Improving constant in Poincare inequality on Hamming cube in $L^1$ metric.

The sharp constant in gaussian Poincare inequality was found by Maurey and Pisier. However the sharp constant of this inequality on Hamming cube is not known. It looks like a rather challenging combinatorial problem. Ten years ago Francoise Lust-Piquard and L. Ben Efraim found the estimate from above for this constant. Thus the sharp constant lies between the constant of Maurey, Pisier and the constant of Ben Efraim, Lust-Piquard. I will show that it is strictly smaller than the constant found by Ben Efraim, Lust-Piquard. It is interesting to note that after Ben Efraim, Lust-Piquard estimate, two other ways to estimate were found, both of them gave the same estimate as Ben Efraim, Lust-Piquard., so it was a bit suggestive that their constant is the sharp one. It is not.

One more interesting remark: Ben Efraim, Lust-Piquard proof was using a very sophisticated non-commutative harmonic analysis even though the original inequality is of course very much from the usual, commutative world.

Two other known proofs (with the same constant) were using a certain Bellman function.

This is a joint work with Ramon van Handel, Paata Ivanisvili and Dong Li, and our method uses some strange Khintchine inequality.

Algebraic Geometry

Wednesday, November 14, 2018, 4:00pm-5:20pm
4096 East Hall

Karl Schwede (University of Utah)

Singularities in mixed characteristic via perfectoid big Cohen-Macaulay algebras

I will discuss work with Linquan Ma that develops a theory of singularities (of pairs) in mixed characteristic by utilizing perfectoid big Cohen-Macaulay algebras (as constructed by Andre). This perspective mixes ideas from tight closure theory with those coming from the theory of multiplier ideals - with big Cohen-Macaulayness replacing vanishing theorems associated to resolutions of singularities. In particular, we obtain mixed characteristic versions of rational singularities, KLT singularities and multiplier ideals as some common results such as restriction theorems and transformation rules under finite maps.
RTG Seminar on Geometry, Dynamics and Topology  
**Wednesday, November 14, 2018, 4:00pm-5:30pm**  
3866 East Hall  
**Richard Canary (U Michigan)**  
*Dynamics and the Hitchin component*

Hitchin discovered a component of the space of representations of a surface group into PSL(n,R), which bears many resemblances to the Teichmuller space of Fuchsian representations of the surface group into PSL(2,R). Labourie introduced dynamical techniques to show that these Hitchin representations are discrete, faithful quasi-isometric embeddings. Sambarino associated Anosov flows to Hitchin representations whose periods record the spectral data of the representation.

In this talk, we will see how to use these flows to attach and study dynamical quantities to Hitchin representations, e.g. entropies, Liouville currents and associated Liouville volumes. We will also discuss rigidity results and natural Riemannian metrics on the Hitchin component. (These results are joint work with Martin Bridgeman, Francois Labourite and Andres Sambarino.)

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**Student Homotopy Theory**  
**Thursday, November 15, 2018, 1:00pm-2:30pm**  
2866 East Hall  
**Jack Carlisle (University of Michigan)**  
*Vector Bundles and Characteristic Classes*

When does a vector bundle admit a non-vanishing section? In the case of tangent bundles of spheres, it is a well known fact that we can find such a section if and only if the dimension of the sphere is odd. For general vector bundles, this is a difficult question to answer. Characteristic classes are invariants of vector bundles that can, in many cases, help us answer this question. In this talk we will introduce the Stiefel-Whitney and Chern classes, as well as the Euler class. We will investigate the relationship between these characteristic classes, and use them to answer some interesting topological questions.

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**Commutative Algebra**  
**Thursday, November 15, 2018, 3:00pm-4:00pm**  
4088 East Hall  
**d Schwede (University of Utah)**  
*A Kunz-type characterization of regular rings via alterations*

I will describe joint work with Linquan Ma where we show that a ring A essentially of finite type over a field of characteristic zero is regular if and only if for every regular alteration \( \pi: Y \to \text{Spec } A \) has the property that \( R\pi_* O_Y \) has projective dimension zero (equivalently, finite projective dimension). This should be compared with Kunz’ theorem in positive characteristic which characterizes regular rings by flatness of Frobenius.
An affine toric variety is an algebraic variety whose co-ordinate ring is the semigroup ring corresponding to a finitely generated sub-semigroup of a lattice. In this talk, first, we will see a simple process of obtaining an affine toric variety from a certain convex cone. Then we will construct few well known algebraic varieties by gluing affine toric varieties. We shall also briefly discuss the relation of singularities and compactness of a toric variety with properties of the fan that defines the toric variety.

Carcinogenesis, the transformation from healthy tissue to invasive cancer, is characterized by the progressive accumulation of mutations in a small group of founder cells. This talk focuses on the spread of premalignant cells during the process of carcinogenesis in epithelial tissue, utilizing a spatial stochastic model of mutation accumulation and clonal expansion. We use this model to develop a measure of the length-scale of genetic heterogeneity during carcinogenesis. In addition, we study the rate of expansion of a mutant clone, and discuss the clinical implications that arise from differences in the underlying structure of the tissue.
Geometry
Friday, November 16, 2018, 3:00pm-4:00pm
3866 East Hall
Paul Apisa (Yale)

Using flat geometry to understand the dynamics of every point - Hausdorff dimension, divergence, and Teichmueller geodesic flow

The moduli space of Riemann surfaces admits a Kobayashi hyperbolic metric called the Teichmueller metric. The geodesic flow in this metric can be concretely understand in terms of a linear action on flat surfaces represented as polygons in the plane. In this talk, we will study the dynamics of this geodesic flow using the geometry of flat surfaces.

Given such a flat surface there is a circle of directions in which one might travel along Teichmueller geodesics. We will describe work showing that for every (not just almost every!) flat surface the set of directions in which Teichmueller geodesic flow diverges on average - i.e. spends asymptotically zero percent of its time in any compact set - is 1/2.

In the first part of the talk, we will recall work of Masur, which connects divergence of Teichmueller geodesic flow with the dynamics of straight line flow on flat surfaces.

In the second part of the talk, we will describe the lower bound (joint with H. Masur) and how it uses flat geometry to prove a quantitative recurrence result for Teichmueller geodesic flow.

In the third and final part of the talk, we will describe the upper bound (joint with H. al-Saqban, A. Erchenko, O. Khalil, S. Mirzadeh, and C. Uyanik), which adapts the work of Kadyrov, Kleinbock, Lindenstrauss, and Margulis to the Teichmueller geodesic flow setting using Margulis functions.
Combinatorics
Friday, November 16, 2018, 3:00pm-4:00pm
2866 East Hall
James Propp (University of Massachusetts, Lowell)
Dynamics from Posets

In recent decades, partially ordered sets have been a fertile source of interesting discrete dynamics. The initial focus of researchers like Cameron, Fon-Der-Flaass, Panyushev, Armstrong, Stump, Thomas, Striker, and Williams was on combinatorics, but over time it has emerged that the combinatorial viewpoint is merely the tip (or rather the 0-skeleton) of an iceberg, and that the full story involves continuous piecewise-linear actions on polytopes. Furthermore, although the original emphasis was on the surprising way these maps tend to be periodic, my work with Einstein, Joseph and Roby has brought out another set of surprises: for most of these dynamical systems, many functions \( f \) have the property that \( f \) has the same average value on every orbit. This "homomesy phenomenon" is quite robust, and crops up even in cases where the orbit structure is exceedingly complicated.

I will give an accessible overview of this work requiring no knowledge of partially ordered sets beyond the basic notions of order ideals and antichains, and no knowledge of dynamical systems theory at all.

For those already familiar with work in this area, I will also discuss two recent results. One is a homomesy result for a nonperiodic action on a polytope, poised halfway between combinatorics and ergodic theory. The other is a viewpoint that uses linear algebra to build a bridge between homomesies for order ideal statistics and homomesies for antichain statistics. This linearization idea also works for dynamical systems associated with cluster algebras, though we do not know if it provides genuinely new information.

Junior Colloquium Series
Friday, November 16, 2018, 4:00pm-5:00pm
3088 East Hall
Michael Von Korff (Curriculum Associates)
Fulfilling the Promise of Online Mathematics Instruction

Education visionaries have long promised that edtech would upend the K-12 classroom by delivering personalized instruction to students, empowering teachers with real-time data, and enabling teachers to spend more quality instructional time in "flipped classrooms". While the edtech field is growing rapidly, it has yet to truly revolutionize K-12 education.

In this talk, I'll explain some of the key promises and challenges of online math instruction, as well as the role that current and former mathematicians and math educators might play in shaping the future of edtech.
Student Machine Learning  
Friday, November 16, 2018, 5:00pm-6:00pm  
4088 East Hall  
Brian Chen (University of Michigan)  
Recurrent Neural Networks

This talk will be about Recurrent Neural Networks, and some examples of applications. Compared to standard neural networks, which take in an input vector of fixed size, Recurrent Neural Networks are useful in being able to process sequences of input vectors (e.g. letters, time series data, and video frames)