Monday, November 11, 2019

11:00am-11:50am **Representation Stability** -- Jenny Wilson (UM) *The high-degree cohomology of SL_n(Z), Part II* -- 3866 East Hall

12:00pm-12:50pm **Mathematical Biology** -- Matthew O'Meara (Dept of Computational Medicine & Bioinformatics, University of Michigan) *Experimental Design for Large Scale Virtual Screening* -- 335 West Hall

3:00pm-4:00pm **Student Dynamics** -- Mitul Islam (UM) *Random walks on word hyperbolic groups* -- 3866 East Hall

3:00pm-4:00pm **RTG Seminar on Number Theory** -- Karol Koziol (University of Michigan) *The p-adic Local Langlands Correspondence for GL_2(Q_p)* -- 4088 East Hall

3:00pm-4:00pm **Student Combinatorics** -- Multiple Speakers () *Bring Your Work to Work Day* -- 3096 East Hall

4:00pm-5:00pm **Integrable Systems and Random Matrix Theory** -- Antonio Auffinger (Northwestern University) *Counting saddles in high dimensions* -- 1866 East Hall

4:00pm-5:00pm **Student Algebraic Geometry** -- Sridhar Venkatesh (UM) *Geometric invariant theory* -- B745 East Hall

4:00pm-5:00pm **Student Homotopy Theory** -- Yunze Lu (University of Michigan) *Kervaire invariant one problem* -- 1372 East Hall

Tuesday, November 12, 2019

3:00pm-4:00pm **Student Geometry/Topology** -- Yueqiao Wu (UM) *K-stability for differential geometers* -- 3866 East Hall

4:00pm-5:00pm **Colloquium Series** -- Benoit Pausader (Brown University) *Asymptotic stability of the Minkowski space for the Einstein-Klein-Gordon equation.* -- 1360 East Hall

Wednesday, November 13, 2019

3:00pm-4:00pm **Student Homotopy Theory** -- Yunze Lu (University of Michigan) *Kervaire invariant one problem* -- 1372 East Hall

3:00pm-4:00pm **Student Arithmetic** -- Patrick Kelley (UM) *Mock Modular Forms* -- 3866 East Hall

4:00pm-5:30pm **Algebraic Geometry** -- Junliang Shen (MIT) *Hitchin systems, hyper-Kaehler geometry, and the P=W conjecture* -- 4096 East Hall

5:30pm-6:30pm **RTG Seminar on Geometry, Dynamics and Topology** -- Ben Dozier (Stony Brook) *Compactifications of spaces of Riemann surfaces and translation surfaces* -- 3866 East Hall

Thursday, November 14, 2019

3:00pm-4:00pm **Topology** -- Ben Dozier (Stony Brook) *Translation surfaces with multiple short saddle connections* -- 3866 East Hall

3:00pm-4:00pm **Commutative Algebra** -- Karen Smith (University of Michigan) *Non-Commutative Resolution of Singularities* -- 4088 East Hall

4:00pm-5:00pm **Differential Equations** -- Beatrice Bong (Perimeter Institute for Theoretical Physics, Waterloo, Canada) *Angular momentum radiated by electromagnetic versus gravitational waves* -- 4088 East Hall
### Friday, November 15, 2019

<table>
<thead>
<tr>
<th>Time</th>
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<tbody>
<tr>
<td>3:00pm-4:00pm</td>
<td><strong>Applied Interdisciplinary Mathematics (AIM)</strong> -- Doug Wright (Drexel University) <em>Traveling waves in diatomic FPUT lattices</em> -- 1084 East Hall</td>
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<td>4:00pm-6:00pm</td>
<td><strong>Junior Colloquium Series</strong> -- Asaf Cohen (Michigan) <em>Stochastic processes, control problems, and games (Research at Michigan Series)</em> -- 3088 East Hall</td>
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<tr>
<td>4:00pm-5:30pm</td>
<td><strong>Preprint Algebraic Geometry</strong> -- Jakub Witaszek (UM) <em>Nearby cycles and semipositivity in positive characteristic, following Langer</em> -- 2866 East Hall</td>
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Abstracts for the week of November 10th, 2019 - November 16th, 2019

Representation Stability
Monday, November 11, 2019, 11:00am-11:50am
3866 East Hall
Jenny Wilson (UM)
*The high-degree cohomology of SL_n(Z), Part II*

Mathematical Biology
Monday, November 11, 2019, 12:00pm-12:50pm
335 West Hall
Matthew O'Meara (Dept of Computational Medicine & Bioinformatics, University of Michigan)
*Experimental Design for Large Scale Virtual Screening*

Virtual screening of commercial make-on-demand chemical libraries is a promising strategy for rapid, low-cost drug discovery. However, due to the uncertain predictive accuracy, it is not clear how to best integrate docking into discovery campaigns, an instance of a general problem for applying complex prediction methods. To address this challenge, I will describe how we designed a Bayesian optimal experiment to estimate the hit-rate as a function of predicted free energy of binding by carefully selecting ~500 compounds test in an in vitro binding assay. Using this an example, I will then describe a novel statistical and computational framework for efficiently computing Bayesian optimal designs. The core idea is to use stochastic gradient descent to simultaneously optimize the parameters of variational bounds of the expected information gain and the experimental degrees of freedom. Through implementing this in Pyro a probabilistic programming language built on PyTorch, this method can scale to designing highly informative experiments to calibrate a wide range of predictive models.

Student Dynamics
Monday, November 11, 2019, 3:00pm-4:00pm
3866 East Hall
Mitul Islam (UM)
*Random walks on word hyperbolic groups*

The classical random walk on an integer lattice $\mathbb{Z}^d$ is often (aptly) described by the colloquial catch-phrase: "A drunken man always finds his way home, but a drunken bird may get lost forever". I will discuss the case for random walks on word hyperbolic groups. The goal will be to understand the connection between the (analytic) exit measure for a large class of ‘nice’ random walks on the group and the (geometric) Patterson-Sullivan measure on the boundary of the group. This is based on a result of Gouëzel-Mathéus-Maucourant. No background on random walks will be assumed.
The classical Local Langlands Correspondence for the group $GL_2(Q_p)$ gives a bijection between certain complex representations of $GL_2(Q_p)$ and certain two-dimensional complex representations of the absolute Galois group of $Q_p$. This correspondence satisfies many nice properties, and may be viewed as a "rank 2" analog of local class field theory. I'll briefly review these results, and then try to explain an equally interesting version of this correspondence with complex coefficients replaced by $p$-adic coefficients.

I will discuss the almost surely asymptotics of the number of saddles in the spherical $p$ spin-glass model. Our main result confirms the almost surely existence of a layered structure of critical points of the energy landscape. I will then relate this computation to a detailed information about the landscape around the ground state energy and the structure of the Parisi measure at zero temperature. The proofs heavily use tools from random matrix theory, including large deviation principles and rigidity results.

Based on a joint work with Julian Gold (Northwestern University) and Yi Gu (Northwestern University).
Student Algebraic Geometry  
Monday, November 11, 2019, 4:00pm-5:00pm  
B745 East Hall  
Sridhar Venkatesh (UM)  
*Geometric invariant theory*

Geometric Invariant Theory (GIT) deals with the construction of quotients of group actions in algebraic geometry. I will first explain what we do in the affine case and then when we move on to the quasi projective case, I will show how the notion of semistability naturally arises and how the set of semi-stable points admits a good quotient. If time permits, I will then give an outline of how the question of classifying (semistable) vector bundles of a given rank and degree over a curve can be phrased as a GIT question (James has actually already done this in his talk!). The talk will only require familiarity with the language of varieties. No scheme theory would be required.

Complex Analysis, Dynamics and Geometry  
Monday, November 11, 2019, 4:00pm-5:00pm  
3866 East Hall  
Kostas Tsouvalas (U(M))  
*Borel Anosov groups in even dimensions*

Anosov representations of word hyperbolic groups into real reductive Lie groups were introduced by Labourie in his study of the Hitchin component. They form a rich class of discrete subgroups of Lie groups generalizing classical convex cocompact subgroups of the isometry group of real hyperbolic spaces. Borel Anosov representations into projective (or special) linear groups are the strongest kind of Anosov representations. In this talk, we are going to characterize word hyperbolic groups which admit Borel Anosov representations into PGL(d,R) when d is of the form 4q+2. This answers a question of Andres Sambarino for these dimensions.
A number of questions in Galois theory can be phrased in the following way: how large (in various senses) can the Galois group $G$ of an extension of the rational numbers be, if the extension is only allowed to ramify at a small set of primes? If we assume that $G$ is abelian, class field theory provides a complete answer, but the question is open in almost every nonabelian case, since there is no known way to systematically and explicitly construct such extensions in full generality.

However, due to some recent advances in our understanding of various types of arithmetic families (with some heavy lifting due to the representation theory of reductive groups over local fields), it has become possible to apply certain "coarse" or "soft" methods in the theory of automorphic forms to attack problems like the above. For concreteness, we will focus on a specific question raised by R. Greenberg and show that such "slightly ramified" number fields, despite not being explicitly constructible by known methods, turn out to "exist in abundance" and allow us to find bounds on the sizes of such Galois groups.

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Chromatic Homotopy Theory

**Monday, November 11, 2019, 5:30pm-6:30pm**

3088 East Hall

Attilio Castano (UM)

*Formal Groups, heights, Stratification of $M_{\text{FG}}$.*

Following lectures 11-13 from [http://www.math.harvard.edu/~lurie/252x.html](http://www.math.harvard.edu/~lurie/252x.html).

Student Geometry/Topology

**Tuesday, November 12, 2019, 3:00pm-4:00pm**

3866 East Hall

Yueqiao Wu (UM)

*K-stability for differential geometers*

By differential geometers, I mean anyone who has seen some Riemannian geometry in their life. In this talk we aim to motivate the notion of K-stability for Fano manifolds and give a differential geometric definition of Futaki invariant. Along the way we will show the interesting fact that the space of all Kähler potentials in a fixed Kähler class is formally an infinite dimensional negatively curved Riemannian symmetric space. Depending on the interest of the audience, I might mention very briefly what the corresponding algebro-geometric definition is.
**Colloquium Series**

*Tuesday, November 12, 2019, 4:00pm-5:00pm*

**1360 East Hall**

**Benoit Pausader (Brown University)**

*Asymptotic stability of the Minkowski space for the Einstein-Klein-Gordon equation.*

We present recent work with A. Ionescu on the stability of the simplest equilibrium in the Einstein-massive-scalar field system. This is one of the simplest model from general relativity that introduces a "matter-field" (where information propagates slower than the speed of light). One of the novel aspects is that we start with initial data which are rather general: the decay of the metric is slower than the "mass term" 1/r and consistent with the assumptions on the second fundamental form (i.e. time slices are not necessarily maximal or "almost radially symmetric").

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**Student Homotopy Theory**

*Wednesday, November 13, 2019, 3:00pm-4:00pm*

**1372 East Hall**

**Yunze Lu (University of Michigan)**

*Kervaire invariant one problem*

For a framed (4k+2)-manifold M, there is associated Kervaire invariant (zero or one) under framed cobordism which measures whether M is cobordant to any manifolds homotopy equivalent to a sphere. In 2009, Hill-Hopkins-Ravenel solved the problem by showing that the dimensions must be 2, 6, 10, 14, 30, 62 and 126 for Kervaire invariant one. This problem also turns out to be related to the Adams spectral sequence and the stable homotopy groups of spheres. In this week's talk I will survey the history and context of the problem, and next week I will explain the outline of the proof.

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**Student Arithmetic**

*Wednesday, November 13, 2019, 3:00pm-4:00pm*

**3866 East Hall**

**Patrick Kelley (UM)**

*Mock Modular Forms*

In his final letter to Hardy in 1920, Ramanujan described several q-series he called "mock theta functions", which he thought "should enter into mathematics as beautifully as ordinary theta functions". Understanding these functions and their relationship to classical modular forms sparked a mathematical mystery that persisted until the invention of mock modular forms and harmonic weak Maass forms in the works of Zwegers (2002) and Bruinier-Funke (2004). This talk will explain the basics of mock modular forms and explore a few applications to combinatorics and arithmetic geometry. If time permits, then we will discuss the open problem of understanding "mock automorphic representations".

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Algebraic Geometry
Wednesday, November 13, 2019, 4:00pm-5:30pm
4096 East Hall
Junliang Shen (MIT)
Hitchin systems, hyper-Kaehler geometry, and the P=W conjecture

Lagrangian fibrations play a crucial role in the study of hyper-Kaehler geometry and integrable systems. The P=W conjecture by de Cataldo, Hausel, and Migliorini suggests a surprising connection between the topology of Lagrangian fibrations and Hodge theory. In this talk, we will first discuss a compact version of this phenomenon, based on joint work with Andrew Harder, Zhiyuan Li, and Qizheng Yin. Then we will focus on interactions between compact and noncompact hyper-Kaehler geometry. Such connections lead to new progress on the P=W conjecture for Hitchin systems and character varieties. This is joint work with Mark de Cataldo and Davesh Maulik.

Financial/Actuarial Mathematics
Wednesday, November 13, 2019, 4:00pm-5:00pm
1360 East Hall
Bin Zou (University of Connecticut)
Optimal Bookmaking

We introduce a general framework for continuous-time betting markets, in which a bookmaker can dynamically control the prices of bets on outcomes of random events. In turn, the prices set by the bookmaker affect the rate or intensity of bets placed by gamblers. The bookmaker seeks a price process that maximizes his expected (utility of) terminal wealth. We obtain explicit solutions or characterizations to the bookmaker's optimal bookmaking problem in various interesting models.

Joint work with Matthew Lorig and Zhou Zhou.
RTG Seminar on Geometry, Dynamics and Topology  
Wednesday, November 13, 2019, 4:00pm-5:30pm  
3866 East Hall  
Ben Dozier (Stony Brook)  
*Compactifications of spaces of Riemann surfaces and translation surfaces*

I will begin with a review of how a hyperbolic surface/Riemann surface/algebraic curve can degenerate. By adding degenerate surfaces to the moduli space, we get the Deligne-Mumford compactification, an object which has been studied intensively from many different viewpoints.

I will then discuss analogous compactification questions for strata of translation surfaces (a translation surface can be thought of as a Riemann surface together with a holomorphic 1-form). Strata admit different compactifications depending on how much information about the shape of degenerating surfaces is remembered in the limit. I will give an overview of these, and discuss how they interact with Deligne-Mumford. There will be many pictures!

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Topology  
Thursday, November 14, 2019, 3:00pm-5:00pm  
3866 East Hall  
Ben Dozier (Stony Brook)  
*Translation surfaces with multiple short saddle connections*

Questions about billiards on rational polygons can be converted into questions about the straight-line flow on translation surfaces. These in turn can be converted (via renormalization) into questions about the dynamics of the SL_*2*(R) action on strata of translation surfaces. By the pioneering work of Eskin-Mirzakhani, to understand dynamics on strata, one is led to study “affine” measures.

It is natural to ask about the interaction between measures of certain subsets of surfaces and the geometric properties of the surfaces. I will discuss a proof of a bound on the volume, with respect to any affine measure, of the locus of surfaces that have multiple independent short saddle connections. This is a strengthening of the regularity result proved by Avila-Matheus-Yoccoz. A key tool is the new compactification of strata due to Bainbridge-Chen-Gendron-Grushhevsky-Moller, which gives a good picture of how a translation surface can degenerate.
Consider a finitely generated normal commutative algebra $R$ over a field $K$. A non-commutative resolution of singularities of $\text{Spec } R$ is a (non-commutative) $R$-algebra $A$ with finite global dimension of the form $\text{End}(M)$ where $M$ is some finitely generated reflexive $R$-module. The existence of a non-commutative resolution for a commutative ring $R$ places strong conditions on $R$, such as rational singularities. In this talk, we discuss how in prime characteristic, the Frobenius can be used to construct non-commutative resolutions of nice enough rings. We conjecture that for a strongly $F$-regular ring $R$, $\text{End}(F_*R)$ is a non-commutative resolution of $R$, where $F_*R$ denotes $R$ viewed as an $R$-module via restriction of scalars from Frobenius. We prove this conjecture when $R$ is the coordinate ring of an affine toric variety. We also show that for toric rings, the ring of differential operators $D(R)$ has finite global dimension (joint with Eleonore Faber and Greg Muller).

Surprisingly, angular momentum flux in electromagnetism cannot be expressed entirely in terms of the field's radiative degrees of freedom. Its expression also involves Coulombic parts of the field, in the form of a charge aspect. Guided by the strong analogy between radiative processes in electromagnetism and gravitation, one might expect that the angular momentum flux in general relativity also involves Coulombic pieces that may have been missed by specializing the flux to periodic sources at rest with respect to the frame in which the flux is evaluated. To test this, we bring together the Landau-Lifshitz formalism, which provides specific definitions for angular momentum and its associated flux, and the Bondi formalism, which provides a systematic expansion of the metric of any asymptotically flat spacetime in inverse powers of the distance away from the matter distribution. We obtain a new expression for the flux of angular momentum, which is not restricted to sources at rest nor to periodic sources. This new expression is equivalent to the standard formula when these restrictions are put in place. Contrary to expectations based on the analogy between electromagnetism and gravitation, no Coulombic information appears in the flux of angular momentum in general relativity.
Applied Interdisciplinary Mathematics (AIM)
Friday, November 15, 2019, 3:00pm-4:00pm
1084 East Hall
Doug Wright (Drexel University)
Traveling waves in diatomic FPUT lattices

We study the existence of solitary waves in a diatomic Fermi-Pasta-Ulam-Tsingou (FPUT) lattice. For monatomic FPUT the traveling wave equations are a regular perturbation of the Korteweg-de Vries (KdV) equation's but, surprisingly, we find that for the diatomic lattice the traveling wave equations are a singular perturbation of KdV's. Using a method first developed by Beale to study traveling solutions for capillary gravity waves we demonstrate that for wave speeds in slight excess of the lattice's speed of sound there exists nontrivial traveling wave solutions which are the superposition an exponentially localized solitary wave and a periodic wave whose amplitude is extremely small. That is to say, we construct “nanopteron” solutions. The presence of the periodic wave is an essential part of the analysis and is connected to the fact that linear diatomic lattices have optical band waves with any possible phase speed.

Combinatorics
Friday, November 15, 2019, 3:00pm-4:00pm
4096 East Hall
Terrence George (Brown University)
Spectra of biperiodic planar networks

A biperiodic planar network is a graph embedded on a torus and a function called conductance, that associates to each edge of the graph a non-zero complex number. The fundamental operator in the study of networks is the discrete Laplacian. Associated to the Laplacian of a biperiodic planar network is its spectral transform, a curve and a divisor on it. We provide a classification of biperiodic planar networks in terms of the spectral transform. The space of networks has a large group of automorphisms that arise from the Y-Delta move. We show that these automorphisms are linearized by the spectral transform.
**Geometry**

Friday, November 15, 2019, 4:00pm-5:00pm  
3866 East Hall  
Spencer Dowdall (Vanderbilt University)  
*Discretely shrinking targets in moduli space*

Given a nested decreasing family of targets $B_n$ in a measure space $X$ equipped with a flow $\phi_t$ (or transformation), the shrinking target problem asks to characterize when there is a full measure set of points $x$ that hit the targets infinitely often in the sense that $\{n \in \mathbb{N} : \phi_n(x) \in B_n\}$ is unbounded. This talk will examine the discrete shrinking target problem for the Teichmüller flow on the moduli space of unit-area quadratic differentials and show that for any ergodic probability measure, almost every differential will hit a nested spherical targets infinitely often provided the measures of the targets are not summable. Our key tool is an effective mean ergodic theorem stating that the time-average of any $L^2$ function converges to its space-average at a uniform rate in $L^2$. As an application, we obtain a logarithm law describing how quickly generic discrete geodesic trajectories accumulate on a given point. Joint with Grace Work.

**Junior Colloquium Series**

Friday, November 15, 2019, 4:00pm-6:00pm  
3088 East Hall  
Asaf Cohen (Michigan)  
*Stochastic processes, control problems, and games (Research at Michigan Series)*

I will present some basic concepts and tools of the theory of stochastic processes, starting from discrete-time (stochastic) control theory and game theory. Also, I will present the main open problem in discrete-time stochastic games: whether every stochastic game with finitely many players ($N>2$), states, and actions, has a uniform equilibrium payoff.

Then I will motivate the continuous-time models making the connection between stochastic control and games with partial differential equations. I will end the talk with a presentation of asymptotic analysis of many-player games using the concept of mean-field games introduced by Pierre-Louis Lions and Jean-Michel Lasry (2006).

**Preprint Algebraic Geometry**

Friday, November 15, 2019, 4:00pm-5:30pm  
2866 East Hall  
Jakub Witaszek (UM)  
*Nearby cycles and semipositivity in positive characteristic, following Langer*

http://front.math.ucdavis.edu/1902.05745