**Monday, January 29, 2018**

4:00pm-5:00pm  **Integrable Systems and Random Matrix Theory** -- Kirill Vaninsky (Michigan State University) *Hamiltonian formalism for the finite open Toda lattice and its spectral curves* -- 1866 East Hall

4:00pm-5:00pm  **Student Combinatorics Seminar** -- Francesca Gandini (University of Michigan) *All roads lead to the associahedron!* -- 3866 East Hall

4:10pm-5:30pm  **Group, Lie and Number Theory** -- Jessica Fintzen (IAS) *Representations of p-adic groups* -- 4088 East Hall

**Tuesday, January 30, 2018**

3:00pm-4:00pm  **Student Geometry/Topology** -- Jasmine Powell (University of Michigan) *Similarities between Julia sets and the Mandelbrot set* -- 3866 East Hall

3:00pm-4:00pm  **Student Commutative Algebra** -- Robert Walker (University of Michigan) *Symbolic Powers Basics: Problem Session* -- 3096 East Hall

3:00pm-4:00pm  **Student Representation Theory** -- Jonathan Gerhard (University of Michigan) *The critical group of a group representation* -- 1866 East Hall

**Wednesday, January 31, 2018**

3:00pm-4:00pm  **Student Arithmetic** -- Yiwang Chen (UM) *Tate-Shafarevich group and class group* -- 1866 East Hall

4:00pm-5:00pm  **Financial/Actuarial Mathematics** -- Gaoyue Guo (Oxford) *Some numerical aspects of (martingale) optimal transportation* -- 1360 East Hall

4:00pm-5:30pm  **RTG Seminar on Geometry, Dynamics and Topology** -- Maxime Scott (Indiana University) *Kleinian groups I* -- 3866 East Hall

4:10pm-5:30pm  **Algebraic Geometry** -- Asher Auel (Yale University) *A tale of two-three fourfolds* -- 4096 East Hall

**Thursday, February 01, 2018**

3:00pm-4:00pm  **Commutative Algebra** -- Ilya Smirnov (University of Michigan) *Finite determinacy for F-invariants.* -- B735 East Hall

4:00pm-5:00pm  **Student Dynamics** -- Salman Siddiqi (University of Michigan) *Chaotic behavior in dynamical systems* -- 1866 East Hall

4:10pm-5:30pm  **Preprint Algebraic Geometry Seminar** -- Igor Dolgachev (UM) *Non-liftable Calabi-Yau varieties in characteristic p (following Achinger-Zdanowicz)* -- 2866 East Hall

5:00pm-6:00pm  **Topology** -- Justin Lanier (Georgia Tech) *Normal generators for mapping class groups are abundant* -- 1866 East Hall

5:00pm-6:00pm  **Representation Stability** -- Trevor Hyde (University of Michigan) *Asymptotic stability of polynomial statistics* -- 3866 East Hall

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Weekly Seminar & Events Bulletin
January 28th, 2018 - February 3rd, 2018

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<td>10:00am-11:00am</td>
<td><strong>Symplectic Reading Group</strong> -- Dan Burns (UM) <em>Recap of symplectic rigidity and displacement energy</em> -- 1360 East Hall</td>
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<td>3:00pm-4:00pm</td>
<td><strong>Applied Interdisciplinary Mathematics (AIM)</strong> -- Gino Biondini (State University of New York at Buffalo) <em>Modulational instability and small dispersion limit of nonlinear waves</em> -- 1084 East Hall</td>
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<td>3:10pm-4:00pm</td>
<td><strong>Student Algebraic Geometry</strong> -- Will Dana (UM) <em>Invariant Theory and Hilbert's 14th Problem</em> -- 3096 East Hall</td>
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<td>3:10pm-4:10pm</td>
<td><strong>Group, Lie and Number Theory</strong> -- Michael Harris (Columbia University) <em>Chern classes of automorphic vector bundles (note special day, time, place)</em> -- 1096 East Hall</td>
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<td>4:00pm-5:00pm</td>
<td><strong>Geometry</strong> -- Eckhard Meinrenken (University of Toronto) <em>TBA (joint with Colloquium)</em> -- 1360 East Hall</td>
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<td>4:10pm-5:00pm</td>
<td><strong>Colloquium Series</strong> -- Eckhard Meinrenken (University of Toronto) <em>Some normal form theorems in differential geometry</em> -- 1360 East Hall</td>
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<td><strong>Student AIM Seminar</strong> -- Saibal De (University of Michigan) <em>Green's Functions, Boundary Integral Equations and Rotational Symmetry: Constructing a Fast Solver for Stokes' Equation</em> -- 1084 East Hall</td>
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<td><strong>Combinatorics</strong> -- Nate Harman (University of Chicago) <em>Quantum integer valued polynomials and stable representation theory</em> -- 4088 East Hall</td>
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Abstracts for the week of January 28th, 2018 - February 3rd, 2018

Integrable Systems and Random Matrix Theory
Monday, January 29, 2018, 4:00pm-5:00pm
1866 East Hall
Kirill Vaninsky (Michigan State University)

Hamiltonian formalism for the finite open Toda lattice and its spectral curves

A Hamiltonian formalism for integrable systems is a well-studied topic. Nevertheless, there is no approach which will cover all known examples integrable with the machinery of algebraic geometry. Very often there are no answers even to the simplest questions. We will formulate the main conjecture of the author regarding Poisson structures for these integrable systems. As an example, we consider the finite open Toda lattice.

Student Combinatorics Seminar
Monday, January 29, 2018, 4:00pm-5:00pm
3866 East Hall
Francesca Gandini (University of Michigan)

All roads lead to the associahedron!

You may know that in ancient times all roads lead to Rome. In combinatorics it seems that all roads lead to the associahedron! Working through a small example, we will see that the following combinatorial structures give rise to an associahedron: triangulations of the n-gon, binary trees, associativity rules, Catalan numbers, frieze patterns, pseudolines arrangements, cluster algebras, and toric varieties. In this talk, time permitting, I will show how all of these concepts relate to our humble polytope. No specific background is required, I will use one motivating example to bring the audience on a tour de force through combinatorics.

Group, Lie and Number Theory
Monday, January 29, 2018, 4:10pm-5:30pm
4088 East Hall
Jessica Fintzen (IAS)

Representations of $p$-adic groups

The building blocks for representations of $p$-adic groups are called supercuspidal representations. I will survey what is known about the construction of supercuspidal representations, mention questions that remain mysterious until today, and explain some recent developments.
Student Geometry/Topology  
**Tuesday, January 30, 2018, 3:00pm-4:00pm**  
3866 East Hall  
**Jasmine Powell (University of Michigan)**  
*Similarities between Julia sets and the Mandelbrot set*  

If you take a Julia set corresponding to a rational map and zoom in at different points, it displays a lot of fractal-like self-similarity. The same is true for the Mandelbrot set. Furthermore, at certain points, if you zoom in on both the Mandelbrot set and the corresponding Julia set at that point and compare the two to each other, they look remarkably similar. In this talk, we will explore this phenomenon and describe the similarity between these sets more precisely.

Student Commutative Algebra  
**Tuesday, January 30, 2018, 3:00pm-4:00pm**  
3096 East Hall  
**Robert Walker (University of Michigan)**  
*Symbolic Powers Basics: Problem Session*  

I will first present some facts needed for the quartet of exercises, and then ask you to try to solve them. You can ask questions whenever, and I'll try to give some idea of how to solve them near the end. I expect to include some of these as Examples/Exercises in my dissertation.

Student Representation Theory  
**Tuesday, January 30, 2018, 3:00pm-4:00pm**  
1866 East Hall  
**Jonathan Gerhard (University of Michigan)**  
*The critical group of a group representation*  

The critical group of a graph is an interesting algebraic invariant that can be realized in multiple ways. One is by thinking of it as the cokernel of the Laplacian matrix of the graph. Another is as a group of equivalences classes under chip-firing of configurations on the graph. Generalizing this notion of chip-firing to a more general class of matrices allows us to define the critical group of a group representation. We will explore some examples of the similarities and differences that arise when studying the critical groups of these two different objects.

Student Arithmetic  
**Wednesday, January 31, 2018, 3:00pm-4:00pm**  
1866 East Hall  
**Yiwang Chen (UM)**  
*Tate-Shafarevich group and class group*  

A lot of people said that Tate-Shafarevich group is an analog of class group of a field. In the talk I will take a review of some basic definitions and show that Sha of the group of units of a number field K gives the ideal class group of K. We might also talk about some further interpretation of Sha in number fields.
Financial/Actuarial Mathematics  
**Wednesday, January 31, 2018, 4:00pm-5:00pm**  
1360 East Hall  
Gaoyue Guo (Oxford)  
*Some numerical aspects of (martingale) optimal transportation*

Martingale optimal transport (MOT), a version of the optimal transport (OT) with an additional martingale constraint on transport's dynamics, is an optimisation problem motivated by, and contributing to model-independent pricing problems in quantitative finance. Compared to the OT, numerical solution techniques for MOT problems are close to non-existent, relative to the theory and applications. In fact, the martingale constraint destroys the continuity of the value function, and thus renders any of the usual OT approximation techniques unusable. With Obloj, we proved that the MOT value could be approximated by a sequence of linear programming (LP) problems to which we apply the entropic regularisation. Further, we obtain in dimension one the convergence rate, which, to the best of our knowledge, is the first estimation of convergence rate in the literature. In the second part, we consider a semi-discrete Wasserstein distance of order 2, which could be solved by means of Voronoi diagram -- which is a static object in computational geometry. Inspired by a criterion in statistical physics, we may construct a sequence of probability distributions and we aim to show its convergence to some limit related to the minimal energy.

RTG Seminar on Geometry, Dynamics and Topology  
**Wednesday, January 31, 2018, 4:00pm-5:30pm**  
3866 East Hall  
Maxime Scott (Indiana University)  
*Kleinian groups I*

This talk will be an introduction to the theory of Kleinian groups.
Algebraic Geometry
Wednesday, January 31, 2018, 4:10pm-5:30pm
4096 East Hall
Asher Auel (Yale University)
A tale of two-three fourfolds

Deciding whether a given algebraic variety is rational, or birational to projective space, is an age-old and challenging problem in algebraic geometry. The rationality problem for rationally connected varieties has seen incredible advances in the last several years, thanks to a degeneration method for the Chow group of 0-cycles initiated by Voisin, developed by Colliot-Thelene and Pirutka, and recently refined by Schreieder. After summarizing some of these advances, I will speak about joint work with Christian Boehning and Alena Pirutka on the rationality problem for two types of Fano fourfolds lying on the boundary of where different techniques are required: hypersurfaces of bidegree (2,3) in $\mathbb{P}^2 \times \mathbb{P}^3$ and complete intersection of type (2,3) in $\mathbb{P}^6$. The first have index 1 and Picard rank 2, and we prove that the very general such hypersurface is not stably rational by exploiting conic bundle and cubic surface bundle structures. The second have index 2 and Picard rank 1, and are more challenging.

Commutative Algebra
Thursday, February 01, 2018, 3:00pm-4:00pm
B735 East Hall
Ilya Smirnov (University of Michigan)
Finite determinacy for F-invariants.

Singularities arising from differential geometry are often defined by power series, rather than polynomials. In this talk, I will discuss a natural question: how much data can be preserved by truncating the defining power series?

Student Dynamics
Thursday, February 01, 2018, 4:00pm-5:00pm
1866 East Hall
Salman Siddiqi (University of Michigan)
Chaotic behavior in dynamical systems

This talk will be an introduction to dynamical systems: I will describe some mathematical characterizations of chaotic behavior in deterministic systems and discuss some statistical properties that arise from chaos. This should be accessible to anyone familiar with measure theory.

Preprint Algebraic Geometry Seminar
Thursday, February 01, 2018, 4:10pm-5:30pm
2866 East Hall
Igor Dolgachev (UM)
Non-liftable Calabi-Yau varieties in characteristic $p$ (following Achinger-Zdanowicz)

https://arxiv.org/abs/1710.08202
Under what conditions do a group element and all of its conjugates form a generating set for the ambient group? Such an element is called a normal generator. For mapping class groups of surfaces, we give a number of geometric criteria that ensure that a mapping class is a normal generator. With these criteria in hand, we show that every nontrivial periodic element in a mapping class group (except for a hyperelliptic involution) is a normal generator. We also show that if the stretch factor of a pseudo-Anosov mapping class is sufficiently small, then it is a normal generator. Our pseudo-Anosov examples answer a question of Darren Long from 1986. This is joint work with Dan Margalit.

A factorization statistic is any function defined on the space of polynomials which only depends on the factorization type of a polynomial. In this talk I will discuss how the average values of factorization statistics on the space of polynomials with coefficients in a finite field relate to the cohomology of configuration spaces and the representation theory of the symmetric group. In particular, the asymptotic stability of these averages can be interpreted as a concrete manifestation of representation stability.

Abstract: This will be the first meeting of a seminar to read current works in symplectic geometry. The idea is to read clusters of papers on different themes. The first theme this term will be on the work of Leonid Polterovich on the relations between symplectic rigidity and quantum mechanics. The first two sessions will be on the book by Polterovich and Rosen, "Function theory on symplectic manifolds." A copy of a draft of the book is available at Polterovich's website at TAU:

https://sites.google.com/site/polterov/miscellaneous/texts/function-theory-on-symplectic-manifolds.

Anyone interested in participating should send an email to dburns@umich.edu. Suggestions for topics are welcome. A preliminary list of suggested papers is available, too.
Fifty years after Zabusky and Kruskal's discovery of solitons, there still remain many fundamental open questions about nonlinear waves. This talk is devoted to two classical problems involving singular asymptotic limits: (i) the nonlinear stage of modulational instability and (ii) the small dispersion limit of (2+1)-dimensional systems. Modulational instability (MI), namely the instability of a constant background to long-wavelength perturbations, is a ubiquitous nonlinear phenomenon discovered in the 1960's. However, a characterization of the nonlinear stage of MI - namely, the behavior of solutions once the perturbations have become comparable with the background - was missing. In the first part of the talk I will describe recent work on this subject. I will first show how MI manifests itself in the inverse scattering transform for the focusing nonlinear Schroedinger (NLS) equation. Then I will characterize the nonlinear stage of MI by computing the long-time asymptotics of solutions of the NLS equation for localized perturbations of a constant background. For long times, the space-time plane divides into three regions: a left far field and a right far field, in which the solution is approximately constant, and a central region in which the solution is described by a slowly modulated traveling wave. Finally, I will show that this kind of behavior is not limited to the NLS equation, but instead it is shared by many different nonlinear models (including several PDEs, nonlocal systems and differential-difference equations). Regarding small-dispersion, in the 1960s, G.B. Whitham formulated a method that allows one to study the small-dispersion limit of a nonlinear PDE by deriving a set of hyperbolic PDEs describing the modulation of the parameters of the traveling-wave solutions of the original PDE. Whitham modulation theory, as is now called, has been subsequently generalized and applied with great success in a variety of settings. Most results, however, are limited to PDEs in one spatial dimension. In the second part of the talk I will show how one can formulate a (2+1)-dimensional generalization of Whitham modulation theory to derive the genus-1 Whitham modulation equations for a number of systems, including the Kadomtsev-Petviashvili (KP) equation, the two-dimensional Benjamin-Ono equation and a modified KP equation. I will discuss some basic properties of the resulting Whitham systems and I will show how these systems can be used to investigate many interesting questions about solutions of the original PDE, including the temporal dynamics of certain initial conditions and the transverse stability of genus-1 solutions.
The 14th of Hilbert’s 23 problems asks a simple question: given any subfield of the field of rational functions in \( n \) variables, is the subring of polynomials within that subfield finitely generated as a \( k \)-algebra? It also has the interesting status of being one of the Hilbert problems for which the answer is known to be "no". In this talk, we'll look at the historical context of invariant theory surrounding this problem, as well as its larger significance in algebraic geometry, and why Hilbert might have thought it was true. Then we'll show a couple of special cases in which it actually is true, and finally outline the counterexample, constructed by prolific counterexample constructor Masayoshi Nagata in 1959. This talk will be accessible to anyone who has taken 631.

Holomorphic modular forms on the Shimura variety \( S(G) \) attached to the reductive group \( G \) can be interpreted naturally as sections of automorphic vector bundles: locally free sheaves that can be defined analytically by exploiting the structure of a Shimura variety as a quotient of a symmetric space. The construction can also be made algebraic, and in this way one gets a canonical functor from the tensor category of representations of a certain Levi subgroup \( K \) of \( G \) to the tensor category of vector bundles on \( S(G) \), and thus a homomorphism from the representation ring of \( K \) to \( K_0(S(G)) \). When \( S(G) \) is compact we determine how the image of this homomorphism behaves under Chern characters to Deligne cohomology and continuous \( l \)-adic cohomology. When \( S(G) \) is non-compact and of abelian type, we use perfectoid geometry to define Chern classes in the \( l \)-adic cohomology of the minimal compactification of \( S(G) \); these are analogous to the topological cohomology classes defined by Goresky and Pardon, using differential geometry. (Joint work with Helene Esnault.)
Colloquium Series
Friday, February 02, 2018, 4:10pm-5:00pm
1360 East Hall
Eckhard Meinrenken (University of Toronto)
Some normal form theorems in differential geometry

A vector field is “Euler-like” with respect to a submanifold if its linear approximation is the Euler vector field on the normal bundle. We show that such a vector field canonically determines a tubular neighborhood embedding, and use this fact to discuss various normal form theorems in differential geometry. Examples range from Morse's lemma to various splitting theorems for singular foliations.

Student AIM Seminar
Friday, February 02, 2018, 4:10pm-5:00pm
1084 East Hall
Saibal De (University of Michigan)
Green's Functions, Boundary Integral Equations and Rotational Symmetry: Constructing a Fast Solver for Stokes' Equation

Boundary integral equations (BIEs), and in particular, surface integral equations show up everywhere; any fluid-particle interaction model (eg. protein folding) gives rise to these kind of equations. However, despite their prevalence, constructing high order accurate numerical methods to solve these BIEs, especially when the kernel is singular, remains an active area of research even today.

Sometimes though, when we are lucky, we can take advantage of certain symmetries of the problem, and reduce it to simpler integral equations that we know how to solve. For example, a surface integral equation with rotational symmetry can be reduced to a sequence of integral equations on a curve. In this talk, I'll describe this dimensionality reduction for BIEs associated to Stokes' equation.

We will start with an informal (and I hope, intuitive) description of Green's functions and BIEs. Next, we will see how we can use Fourier series for reducing the dimension. Finally, we'll use these ideas to construct a fast numerical solver for Stokes' equation.

Combinatorics
Friday, February 02, 2018, 4:10pm-5:00pm
4088 East Hall
Nate Harman (University of Chicago)
Quantum integer valued polynomials and stable representation theory

We define a certain q-deformation of the ring of integer valued polynomials and discuss its combinatorial and algebraic properties as well as its connection to the asymptotic behavior of the representation theory of general linear groups over finite fields.