

Weekly Seminar & Events Bulletin

February 18th, 2018 - February 24th, 2018

Monday, February 19, 2018

- 4:00pm-5:00pm **Integrable Systems and Random Matrix Theory** -- Elizaveta Rebrova (University of Michigan) *Non-asymptotic spectral properties of the heavy-tailed random matrices* -- 1866 East Hall
- 4:00pm-5:00pm **Complex Analysis, Dynamics and Geometry** -- Maxime Fortier Bourque (University of Toronto) *The Teichmueller space of conformal pentagons* -- 3096 East Hall
- 4:00pm-5:00pm **Student Combinatorics Seminar** -- Gabriel Frieden (University of Michigan) *Evacuation and domino tableaux* -- 3866 East Hall
- 4:10pm-5:30pm **Group, Lie and Number Theory** -- Xianchang Meng (McGill University) *Chebyshev's bias for products of k primes and related applications* -- 4088 East Hall

Tuesday, February 20, 2018

- 12:00pm-1:30pm **Teaching Mathematics** -- Discussion () *Learning Community on Inclusive Teaching Session 2* -- 4866 East Hall
- 3:00pm-4:00pm **Student Geometry/Topology** -- Salman Siddiqi (University of Michigan) *Unipotent flows on homogeneous spaces* -- 3866 East Hall
- 3:00pm-4:00pm **Student Commutative Algebra** -- Robert Walker (University of Michigan) *Intro to Tight Closure and some F -words* -- 3096 East Hall
- 3:00pm-4:00pm **Student Representation Theory** -- Phil Tosteson (University of Michigan) *Representations of finite sets and injections* -- 1866 East Hall
- 4:10pm-5:00pm **Colloquium Series** -- George Pappas (Michigan State University) *Shimura varieties over the integers* -- 1360 East Hall

Wednesday, February 21, 2018

- 3:00pm-4:00pm **Student Arithmetic** -- Trevor Hyde (UM) *TBA* -- 1866 East Hall
- 4:00pm-5:00pm **Financial/Actuarial Mathematics** -- Christoph Belak (University of Trier) *Utility Maximization with Constant Costs* -- 1360 East Hall
- 4:00pm-5:30pm **RTG Seminar on Geometry, Dynamics and Topology** -- Maxime Scott (Indiana University) *The Ahlfors Measure Conjecture* -- 3866 East Hall
- 4:10pm-5:30pm **Algebraic Geometry** -- Alex Perry (Columbia University) *Deformation and derived equivalent but non-birational Calabi-Yau threefolds* -- 4096 East Hall

Thursday, February 22, 2018

- 3:00pm-4:00pm **Commutative Algebra** -- Irena Swanson (Reed College) *Many associated primes of powers of primes* -- B735 East Hall
- 4:00pm-5:30pm **Logic** -- Chris Kapulkin (University of Western Ontario) *Homotopy Type Theory and internal languages of higher categories* -- 3088 East Hall
- 4:00pm-5:00pm **Student Dynamics** -- Samantha Pinella (University of Michigan) *What are Lyapunov Exponents* -- 1866 East Hall
- 5:00pm-6:00pm **Representation Stability** -- Christin Bibby (University of Michigan) *Representation stability of arrangements* -- 3866 East Hall

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Friday, February 23, 2018

- 10:00am-11:00am **Symplectic Reading Group** -- Daniel Irvine (UM) *Quantum formalism and uncertainty inequalities* -- 1360 East Hall
- 12:10pm-2:00pm **Student Homotopy Theory** -- Attilio Castano (University of Michigan) *The Cotangent Complex and the Derived Philosophy* -- 1360 East Hall
- 3:00pm-4:00pm **Applied Interdisciplinary Mathematics (AIM)** -- Eric Keaveny (Imperial College) *Linking the micro- and macro-scales in populations of swimming cells* -- 1084 East Hall
- 3:00pm-4:00pm **Junior Colloquium Series** -- Academic Careers @ Liberal Arts Colleges () *Academic Careers @ Liberal Arts Colleges: Research Presentations* -- 3088 East Hall
- 3:10pm-4:00pm **Student Algebraic Geometry** -- Sanal Shivaprasad (UM) *An introduction to Hodge theory* -- 3096 East Hall
- 4:00pm-5:00pm **Special Events** -- Mariah Birgen, Gavin LaRose, Marie Snipes, Darin R. Stephens () *Academic Careers @ Liberal Arts Colleges: Panel Discussion* -- 4088 East Hall
- 4:10pm-5:00pm **Student AIM Seminar** -- Cupjin Huang (University of Michigan) *The no-cloning theorem and its implications* -- 1084 East Hall
- 4:10pm-5:30pm **Preprint Algebraic Geometry Seminar** -- Emanuel Reinecke (UM) *Ordinary K3 surfaces over finite fields (following Taelman)* -- 4096 East Hall

Abstracts for the week of February 18th, 2018 - February 24th, 2018

Integrable Systems and Random Matrix Theory

Monday, February 19, 2018, 4:00pm-5:00pm

1866 East Hall

Elizaveta Rebrova (University of Michigan)

Non-asymptotic spectral properties of the heavy-tailed random matrices

The non-asymptotic branch of Random Matrix Theory is concerned to get explicit high probability estimates for the large enough, but fixed size matrices (usually in trade of precise constants). This goal naturally brings into play some beautiful methods of high-dimensional probability and geometry, such as concentration of measure phenomenon. I will introduce some ideas and results of the theory, talking about the spectral properties of heavy-tailed random matrices (i.e. with the entries distributions decaying asymptotically slower than gaussian).

Complex Analysis, Dynamics and Geometry

Monday, February 19, 2018, 4:00pm-5:00pm

3096 East Hall

Maxime Fortier Bourque (University of Toronto)

The Teichmueller space of conformal pentagons

A conformal pentagon is a Jordan domain together with 5 labelled marked points along its boundary, up to conformal homeomorphisms. The space of conformal pentagons is 2-dimensional and we are interested in the geometry of the Teichmueller metric on it. This metric is uniquely geodesic and its geodesics can be described explicitly. I will explain the striking similarities between this space and the Hilbert metric on the interior of a regular Euclidean pentagon. This is joint work with Y. Chen, R. Chernov, S. Lee, M. Flores and B. Yang.

Student Combinatorics Seminar

Monday, February 19, 2018, 4:00pm-5:00pm

3866 East Hall

Gabriel Frieden (University of Michigan)

Evacuation and domino tableaux

Evacuation is a map on semistandard Young tableaux with interesting combinatorial properties. For example, the standard Young tableaux fixed by evacuation are in bijection with domino tableaux, and the number of these objects is given by evaluating the q -analogue of the hook-length formula at $q = -1$. In the first part of the talk, I will explain what all of these words mean (assuming no background in tableau combinatorics), and sketch proofs of the above-mentioned results. At the end of the talk, I will discuss a generalization that arose in joint work of the speaker with Mike Chmutov, Dongkwan Kim, Joel Lewis, and Elena Yudovina.

Weekly Seminar & Events Bulletin

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Group, Lie and Number Theory

Monday, February 19, 2018, 4:10pm-5:30pm

4088 East Hall

Xianchang Meng (McGill University)

Chebyshev's bias for products of k primes and related applications

For any $k \geq 1$, we study the distribution of the difference between the number of integers $n \leq x$ with $\omega(n)=k$ or $\Omega(n)=k$ among different arithmetic progressions, where $\omega(n)$ is the number of distinct prime factors of n and $\Omega(n)$ is the number of prime factors of n counted with multiplicity. Under some reasonable assumptions, we show that, if k is odd, the integers with $\Omega(n)=k$ have preference for quadratic non-residue classes; and if k is even, such integers have preference for quadratic residue classes. This result confirms a conjecture of Richard Hudson. However, the integers with $\omega(n)=k$ always have preference for quadratic residue classes. As an application of the method developed for settling the above problem, we consider a conjecture of Greg Martin about the total number of prime factors for integers up to x among different arithmetic progressions.

If time permits, I may mention the generalization of Chebyshev's bias problem to products of irreducible elements in Function Fields. There will be more interesting phenomenon for the function field version due to the existence of real zeros of corresponding L-functions.

Teaching Mathematics

Tuesday, February 20, 2018, 12:00pm-1:30pm

4866 East Hall

Discussion ()

Learning Community on Inclusive Teaching Session 2

This is the second discussion of readings on inclusive teaching in mathematics. Details are available at <http://www.math.lsa.umich.edu/~glarose/dept/teaching/lcit.html>.

Student Geometry/Topology

Tuesday, February 20, 2018, 3:00pm-4:00pm

3866 East Hall

Salman Siddiqi (University of Michigan)

Unipotent flows on homogeneous spaces

I'll discuss Ratner's theorems on unipotent flows on homogeneous spaces: these say that the closures of the orbits of a unipotent flow on a homogeneous space are 'geometric', that orbits equidistribute in their closures, and that the only ergodic probability measures arise from Haar measures on these orbit closures.

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Student Commutative Algebra

Tuesday, February 20, 2018, 3:00pm-4:00pm

3096 East Hall

Robert Walker (University of Michigan)

Intro to Tight Closure and some F-words

I will cover select definitions, results, and examples related to tight closure and F-singularities.

Student Representation Theory

Tuesday, February 20, 2018, 3:00pm-4:00pm

1866 East Hall

Phil Tosteson (University of Michigan)

Representations of finite sets and injections

The category FI (of finite sets and injections) has a beautiful and simple representation theory, which is closely related to the notion of a stable sequence of S_n representations. I will talk about how we can understand representations of FI by studying a Morita-equivalent category, which is "built from the Pieri rule."

Colloquium Series

Tuesday, February 20, 2018, 4:10pm-5:00pm

1360 East Hall

George Pappas (Michigan State University)

Shimura varieties over the integers

Shimura varieties are quotients of hermitian symmetric domains by arithmetic groups. They generalize the classical elliptic modular curves, are defined over number fields and play a central role in number theory and the Langlands program. I will discuss some classical work and more recent progress on the problem of describing the structure of some of these varieties over the integers and, in particular, their reductions modulo primes.

Student Arithmetic

Wednesday, February 21, 2018, 3:00pm-4:00pm

1866 East Hall

Trevor Hyde (UM)

TBA

Financial/Actuarial Mathematics

Wednesday, February 21, 2018, 4:00pm-5:00pm

1360 East Hall

Christoph Belak (University of Trier)

Utility Maximization with Constant Costs

We study the problem of maximizing expected utility of terminal wealth for an investor facing a mix of constant and proportional transaction costs. While the case of purely proportional transaction costs is by now well understood and existence of optimal strategies is known to hold for a very general class of price processes, the case of constant costs remains a challenge since the existence of optimal strategies is not even known in tractable models (such as, e.g., the Black-Scholes model). In this talk, we present a novel approach which allows us to construct optimal strategies in a multidimensional diffusion market with price processes driven by a factor process and for general lower-bounded utility functions.

One of the main challenges for the problem under consideration is that the value function turns out to be piecewise but not globally continuous. We establish this result in two steps:

- (1) We apply the stochastic Perron's method to show that the value function is a discontinuous viscosity solution of the associated dynamic programming PDE (a nonlocal parabolic free boundary problem).
- (2) We establish a local comparison principle for viscosity solutions of this PDE, which implies uniqueness of the value function as well as piecewise continuity.

Having established piecewise continuity, we use a characterization of the value function as the pointwise infimum of a suitable set of superharmonic functions to construct optimal trading strategies. The advantage of this approach is that the pointwise infimum (i.e. the value function) inherits the superharmonicity property, which in turn allows us to prove a verification theorem for candidate optimal strategies requiring only piecewise continuity of the value function. An application of the verification theorem entails the existence of optimal strategies.

In particular, to the best of our knowledge, our approach leads to the first uniqueness result for discontinuous viscosity solutions of nonlocal PDEs and the model is a rare example of a stochastic control with a discontinuous value function which can be solved completely.

This talk is based on joint work with Soren Christensen (University of Hamburg).

Weekly Seminar & Events Bulletin

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RTG Seminar on Geometry, Dynamics and Topology

Wednesday, February 21, 2018, 4:00pm-5:30pm

3866 East Hall

Maxime Scott (Indiana University)

The Ahlfors Measure Conjecture

In 1966, Ahlfors conjectured that if the Lebesgue measure of the limit set of a Kleinian group is positive, then the limit set is the whole Reimann sphere. This conjecture was established by work of Canary in the geometrically finite case, and the general case follows from work of Agol. We will discuss Canary's proof in the geometrically finite case. We will then consider the corresponding statement for rational maps, which happens to be false. Indeed, in 2006, Buff and Cheritat proved that there are rational maps f , (specifically, quadratic polynomials), such that the Julia set $J(f)$ has positive Lebesgue measure, but $J(f)$ is not equal to the whole sphere.

Algebraic Geometry

Wednesday, February 21, 2018, 4:10pm-5:30pm

4096 East Hall

Alex Perry (Columbia University)

Deformation and derived equivalent but non-birational Calabi-Yau threefolds

I will construct a pair of Calabi-Yau threefolds which are deformation and derived equivalent, but not birationally equivalent. I will explain how this gives a counterexample to the birational Torelli problem for Calabi-Yau threefolds, as well as new examples of zero divisors in the Grothendieck ring of varieties. This is joint work with Lev Borisov and Andrei Caldararu.

Commutative Algebra

Thursday, February 22, 2018, 3:00pm-4:00pm

B735 East Hall

Irena Swanson (Reed College)

Many associated primes of powers of primes

We use the notions of splitting and spreading to construct a family of prime ideals in polynomial rings for which the number of associated primes of the second power is exponential in the number of variables. Splitting is a generalization of McCullough-Peeva's step-by-step homogenization. This is joint work with Jesse Kim.

Weekly Seminar & Events Bulletin

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Logic

Thursday, February 22, 2018, 4:00pm-5:30pm

3088 East Hall

Chris Kapulkin (University of Western Ontario)

Homotopy Type Theory and internal languages of higher categories

Homotopy Type Theory (or HoTT) is an approach to foundations of mathematics, building on the homotopy-theoretic interpretation of type theory. In addition to its foundational role, HoTT has been speculated to be the internal language of higher toposes in the sense of Joyal and Lurie.

This talk will be an introduction to HoTT, explaining its main ideas and presenting one way in which the connection between type theory and higher categories can be made precise.

Student Dynamics

Thursday, February 22, 2018, 4:00pm-5:00pm

1866 East Hall

Samantha Pinella (University of Michigan)

What are Lyapunov Exponents

I will define and discuss Lyapunov exponents using examples.

Representation Stability

Thursday, February 22, 2018, 5:00pm-6:00pm

3866 East Hall

Christin Bibby (University of Michigan)

Representation stability of arrangements

We consider linear, toric, and elliptic arrangements for which the cohomology of the complement enjoys representation stability and study their combinatorics (intersection poset) as a key ingredient of stability. Examples include arrangements arising from root systems, as well as those whose complement is an orbit configuration space. This talk will include joint work with Nir Gadish.

Symplectic Reading Group

Friday, February 23, 2018, 10:00am-11:00am

1360 East Hall

Daniel Irvine (UM)

Quantum formalism and uncertainty inequalities

This will sketch the von Neumann formalism of quantum mechanics and some instances of it. Also, an uncertainty inequality, following Polterovich's "Quantum footprints of symplectic rigidity".

Student Homotopy Theory

Friday, February 23, 2018, 12:10pm-2:00pm

1360 East Hall

Attilio Castano (University of Michigan)

The Cotangent Complex and the Derived Philosophy

In this talk, we will introduce a derived variant of the module of Kahler differentials, which goes by the name of the Cotangent Complex. When studying deformation theory, classical algebraic geometry only provides us with tools to study deformations of smooth schemes; however, the cotangent complex allows us to extend these results to the non-smooth case. This is achieved following the derived philosophy: approximating poorly behaved rings with good ones in the same way that in homological algebra we approximate modules by taking free resolutions.

The underlying goal of this talk is to introduce the audience to different ideas underlying derived algebraic geometry while avoiding the technically charged language found in the literature. We will try to keep the talk accessible by focusing our energy in analogies with homological algebra, and avoiding the formalism of model categories introduced by Quillen.

Applied Interdisciplinary Mathematics (AIM)

Friday, February 23, 2018, 3:00pm-4:00pm

1084 East Hall

Eric Keaveny (Imperial College)

Linking the micro- and macro-scales in populations of swimming cells

Swimming cells and microorganisms are as diverse in their collective dynamics as they are in their individual shapes and swimming mechanisms. They are able to propel themselves through simple viscous fluids, as well as through more complex environments where they must interact with other microscopic structures. In this talk, I will describe recent simulations that explore the connection between dynamics at the scale of the cell with that of the population in the case where the cells are sperm. In particular, I will discuss how the motion of the sperm's flagella can greatly impact the overall dynamics of their suspensions. Additionally, I will discuss how in complex environments, the density and stiffness of structures with which the cells interact impact the effective diffusion of the population.

Junior Colloquium Series

Friday, February 23, 2018, 3:00pm-4:00pm

3088 East Hall

Academic Careers @ Liberal Arts Colleges ()

Academic Careers @ Liberal Arts Colleges: Research Presentations

Research Presentations:

Maria Birgen, Professor of Mathematics, Wartburg College

Gavin LaRose, Karen Rhea Collegiate Lecturer & Instructional Technology Program Manager, University of Michigan Department of Mathematics

Marie Snipes, Associate Professor of Mathematics and Statistics, Kenyon College

Darin R. Stephenson, Professor of Mathematics, Hope College

Student Algebraic Geometry

Friday, February 23, 2018, 3:10pm-4:00pm

3096 East Hall

Sanal Shivaprasad (UM)

An introduction to Hodge theory

Hodge theory is the use of differential operators to study the cohomology groups of a smooth manifold. At first, we will talk about the de Rham complex of a Riemannian manifold and introduce the Laplacian operator and harmonic forms. We will sketch a proof of Hodge's theorem that there is a unique harmonic representative in a de Rham cohomology class.

We will then move on to the setting of compact complex manifolds and discuss how the de Rham and Hodge theory interact with the complex structure. We will introduce (p,q) -forms and the Dolbeault operators and talk about the Hodge decomposition for a complex projective variety. From the Hodge decomposition, we get a list of numerical invariants which are organized into the 'Hodge diamond' - we will compute these invariants in some examples.

This talk should be accessible to all first year grad students, although knowledge of some algebraic geometry or differential geometry will be useful.

Weekly Seminar & Events Bulletin
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Special Events

Friday, February 23, 2018, 4:00pm-5:00pm
4088 East Hall

Mariah Birgen, Gavin LaRose, Marie Snipes, Darin R. Stephenson ()
Academic Careers @ Liberal Arts Colleges: Panel Discussion

Presenter: Maria Birgen, Professor of Mathematics, Wartburg College

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Presenter: Gavin LaRose, Karen Rhea Collegiate Lecturer & Instructional Technology Program Manager,
University of Michigan Department of Mathematics

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Presenter: Marie Snipes, Associate Professor of Mathematics and Statistics, Kenyon College

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Presenter: Darin R. Stephenson, Professor of Mathematics, Hope College
Title: Using Convolutional Neural Networks to Identify Bird Species from Birdsong Samples
Darin Stephenson (joint work with Russell Houpt, Sarah Seckler, Paul Pearson, and Mark Pearson)

Abstract: Extending 2016 work by Hope College students Alli VanderStoep and Taylor Rink, our program aims to develop a computer algorithm for determining the species of certain birds given an audio recording of birdsong. Our current data set consists of over 24,000 audio recordings coming from nearly 1,000 different species. I will describe our pre-processing steps which involve the use of real and complex wavelets to denoise birdsong signal and extract time-frequency scalograms. Once the scalograms are developed, we use image recognition techniques to build and train a convolutional neural network to match scalograms with bird species.

Reception Follows at 5:00 PM in Room 4088 East Hall

Weekly Seminar & Events Bulletin

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Student AIM Seminar

Friday, February 23, 2018, 4:10pm-5:00pm

1084 East Hall

Cupjin Huang (University of Michigan)

The no-cloning theorem and its implications

In our classical world, copying is an easy task: you can copy a string in your favorite text editor when coding; you can make a backup of your files locally or on cloud; you can take notes photos or even videos when you attend a talk (like this one). However, things are very different in the quantum region.

In quantum information, the no-cloning theorem claims that it is impossible create an identical copy of an arbitrary unknown quantum state. It is one of the most interesting yet most profound theorems in quantum information, and it has many implications in various subfields in quantum mechanics.

In this talk, I will first introduce the basics of quantum information, including pure states and unitary/isometry evolutions. Then I will provide a proof of the no-cloning theorem. After that, I will talk about several implications of the no-cloning theorem, including secret sharing, quantum teleportation and information disturbance.

The only prerequisite for this talk is a strong foundation in linear algebra. No background knowledge in quantum information is needed.

Preprint Algebraic Geometry Seminar

Friday, February 23, 2018, 4:10pm-5:30pm

4096 East Hall

Emanuel Reinecke (UM)

Ordinary K3 surfaces over finite fields (following Taelman)

<https://arxiv.org/abs/1711.09225>