**Monday, February 04, 2019**

10:00am-11:00am  **Student Homotopy Theory** -- Montek Gill (University of Michigan) *The correspondence between infinite loop spaces and grouplike $E_{\infty}$ spaces* -- 3088 East Hall

3:00pm-4:00pm  **Student Dynamics** -- Karen Butt (UM) *Marked Length Spectrum Rigidity for Negatively Curved Surfaces* -- 3866 East Hall

4:00pm-5:20pm  **Group, Lie and Number Theory** -- Andrew O'Desky (Univ Michigan) *Generalized Prime Counting Functions and $p$-adic Interpolation* -- 4088 East Hall

4:00pm-6:00pm  **Geometry & Physics** -- Brian Willett (KITP-Santa Babara) *The higher dimensional $A$-model and generalized quantum cohomology* -- 4096 East Hall

4:00pm-5:00pm  **Integrable Systems and Random Matrix Theory** -- Guilherme Silva (University of Michigan) *Spectral curves for matrix models. Take I: a numerical analysis perspective* -- 1866 East Hall

4:00pm-5:00pm  **Student Combinatorics** -- Trevor Hyde (University of Michigan) *The Stanley Character Formula* -- 3866 East Hall

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**Tuesday, February 05, 2019**

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

3:00pm-4:00pm  **Student Geometry/Topology** -- Feng Zhu (University of Michigan) *The generic leaf may be a Loch Ness monster* -- 1866 East Hall

3:00pm-3:50pm  **Student Commutative Algebra** -- Monica Lewis (University of Michigan) *Depth and arithmetic rank* -- 3866 East Hall

4:00pm-5:00pm  **Colloquium Series** -- Melanie Matchett Wood (University of Wisconsin-Madison) *Random groups from generators and relations* -- 1360 East Hall

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**Wednesday, February 06, 2019**

2:30pm-4:00pm  **Student Machine Learning** -- Brian Chen (UM) *Deep Feedforward Networks* -- 3866 East Hall

3:00pm-4:00pm  **Combinatorics** -- Nati Linial (Hebrew University of Jerusalem) *Graph metrics* -- note unusual date! -- 4088 East Hall

4:00pm-5:00pm  **Financial/Actuarial Mathematics** -- Oleksii Mostovyi (UConn) *Optimal consumption from investment and labor income in a unifying framework of admissibility* -- 1360 East Hall

4:00pm-5:30pm  **RTG Seminar on Geometry, Dynamics and Topology** -- Andy Putman (University of Notre Dame) *The Johnson filtration is finitely generated* -- 3866 East Hall

4:00pm-5:00pm  **Student Arithmetic** -- Yifeng Huang (University of Michigan) *Diophantine Equations and Arakelov theory* -- 3088 East Hall

4:00pm-5:20pm  **Algebraic Geometry** -- Yongbin Ruan (U Michigan) *Verlinde/Grassmanian Correspondence and quantum K-theory* -- 4096 East Hall

5:00pm-6:00pm  **Working Group on Anderson Localization** -- Joe Kraisler (University of Michigan) *The Anderson Model* -- 4088 East Hall
### Thursday, February 07, 2019

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<thead>
<tr>
<th>Time</th>
<th>Event</th>
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<tr>
<td>3:00pm-4:00pm</td>
<td><strong>Topology</strong> -- Andy Putman (University of Notre Dame) The stable cohomology of the moduli space of curves with level structures -- 4096 East Hall</td>
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<td>3:00pm-4:00pm</td>
<td><strong>Commutative Algebra</strong> -- Monica Lewis () Associated primes and the local cohomology of parameter ideals -- 3866 East Hall</td>
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<td>4:00pm-5:00pm</td>
<td><strong>Differential Equations</strong> -- Dana Mendelson (University of Chicago) Almost sure wellposedness for some nonlinear dispersive equations -- 4088 East Hall</td>
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<td>4:00pm-5:00pm</td>
<td><strong>Student Algebraic Geometry</strong> -- Matt Stevenson (UM) Positivity of divisors -- B735 East Hall</td>
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### Friday, February 08, 2019

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<thead>
<tr>
<th>Time</th>
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<tr>
<td>3:00pm-4:00pm</td>
<td><strong>Applied Interdisciplinary Mathematics (AIM)</strong> -- Takashi Sakajo (Kyoto University) Vortex dynamics on the surface of a torus -- 1084 East Hall</td>
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<td>3:00pm-4:00pm</td>
<td><strong>Combinatorics</strong> -- Melissa Sherman-Bennett (UC Berkeley) Combinatorics of cluster structures in Schubert varieties -- 4088 East Hall</td>
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<tr>
<td>4:00pm-5:00pm</td>
<td><strong>Student AIM Seminar</strong> -- Christiana Mavroyiakoumou (University of Michigan) The Ekman spiral and point vortex motion around boundaries -- 1084 East Hall</td>
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Student Homotopy Theory
Monday, February 04, 2019, 10:00am-11:00am
3088 East Hall
Montek Gill (University of Michigan)

The correspondence between infinite loop spaces and grouplike $E_{\infty}$ spaces

I will describe why both infinite loop spaces and grouplike $E_{\infty}$ spaces (spaces with the action of an $E_{\infty}$ operad together with an existence of inverses condition) ought to yield derived abelian groups, or, more precisely, connective spectra. I will then describe the correspondence between these two types of objects as outlined in May's "The Geometry of Iterated Loop Spaces". No prior exposure to infinite loop spaces or operads will be assumed.

Student Dynamics
Monday, February 04, 2019, 3:00pm-4:00pm
3866 East Hall
Karen Butt (UM)

Marked Length Spectrum Rigidity for Negatively Curved Surfaces

If $M$ is a closed Riemannian manifold of negative curvature then each free homotopy class of curves of $M$ contains a unique closed geodesic. The marked length spectrum of $M$ is the function which assigns to each free homotopy class of closed curves the length of its geodesic representative. In the case where $M$ is a surface, Otal proved that this function determines $M$ completely up to isometry. In this talk, I will explain the main ideas behind Otal's proof. No prior knowledge of differential geometry or dynamics will be assumed.
In the first half of this talk we will introduce the notion of a generalized prime counting function taking values in a vector space. We will also introduce analogous generalizations of the Chebyshev function and the LCM sequence. Our main theorem relates these three quantities by computing an exact formula for the constant of proportionality in the smallest term of their asymptotic expansion. The formula may be understood as a reformulation of Chebotarëv's density theorem and admits a representation-theoretic interpretation. It has the added feature however of making clear a connection with Landau's prime ideal theorem which is not evident from the usual formulation. Furthermore, densities of primes which naturally arise in consideration with non-Galois fields can also be easily calculated by means of the formula.

The second half of the talk will consider an application to p-adic analysis. We do this by giving a general inequality relating quantities associated with any sequence of elements of a number field. By applying our result to the sequence of coefficients of a power series, we will obtain Dwork's Theorem 3 from his paper on the rationality of the local zeta function of an algebraic variety. By applying our result to the sequence of finite differences of another sequence, we will recover and significantly strengthen some existing results in the context of p-adic interpolation.

We define and study a structure that can be associated to supersymmetric gauge theories in two or more spacetime dimensions. This is a generalization of the two dimensional A-model, which is used to study gauged linear sigma models, and defines the equivariant quantum cohomology ring on the low-energy target spaces. The three- and four-dimensional generalizations give rise, respectively, to a trigonometric and elliptic generalization of this construction. These rings naturally describe the fusion of Wilson loop operators in three dimensional theories, generalizing the Verlinde algebra in Chern-Simons theory, and surface operators in four dimensional theories. Using this structure one may also construct the partition function on general three and four dimensional Seifert manifolds. All of these structures obey interesting relations under supersymmetric dualities, and have connections to the integrable systems through the gauge-Bethe correspondence.
Integrable Systems and Random Matrix Theory  
Monday, February 04, 2019, 4:00pm-5:00pm  
1866 East Hall  
Guilherme Silva (University of Michigan)  
*Spectral curves for matrix models. Take I: a numerical analysis perspective*

A spectral curve for a matrix model is, in very loose terms, an equation with unknown being the Cauchy (a.k.a. Stieltjes) transform of the limiting spectral density. Sometimes also known as master loop equation or string equation, it commonly appears as an algebraic equation, hence the name "curve" as it determines an algebraic curve. A classical situation is given by the celebrated semicircle law, whose Cauchy transform satisfies a very simple algebraic equation of degree 2.

In this series of two talks we discuss several aspects of spectral curves. In the first of these talks, we explore a problem in numerical analysis, namely constructing quadrature rules for highly oscillatory integrals, to revisit several old results and learn how we can use techniques from random matrix theory to get insight into the distribution of the corresponding complex quadrature points. This first talk is based on joint work with Andrew Celsus (University of Cambridge).

In the second talk, we take a slight more abstract perspective. Starting from an "ideal" spectral curve, which is known to exist in several examples, we show how to reconstruct a variational problem for the eigenvalue distribution, ultimately giving a characterization of the limiting eigenvalue distribution for a random matrix model with external source. A key aspect here is the determination of a "free boundary" for the variational problem, which is done with the help of quadratic differentials on the algebraic curve. This second part is based on joint work with Andrei Martinez-Finkelshtein (Baylor University).

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**Student Combinatorics**  
Monday, February 04, 2019, 4:00pm-5:00pm  
3866 East Hall  
Trevor Hyde (University of Michigan)  
*The Stanley Character Formula*

The Stanley character formula expresses the values of irreducible characters of the symmetric group in terms of topological branched coverings of the sphere. In this talk I will discuss this surprising connection between geometry and combinatorics. We will end with applications to the asymptotic representation theory of symmetric groups.

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**Teaching Mathematics**  
Tuesday, February 05, 2019, 11:30am-1:00pm  
4866 East Hall  
Discussion ()  
*LCIT Discussion*

A discussion session of our Learning Community on Inclusive Teaching.
Foliations are useful geometric and dynamical objects. Topologically, their individual pieces (leaves) can be very complicated, but exhibit some broad structural features that might be described as strikingly simple. This talk will introduce some results of Ghys to this effect, and will take the opportunity to (attempt to) draw many examples, and mention connections to related topics such as infinite-type surfaces and certain aspects of geometric group theory.

Feng Zhu (University of Michigan)
*The generic leaf may be a Loch Ness monster*

Student Commutative Algebra
Tuesday, February 05, 2019, 3:00pm-3:50pm
3866 East Hall
Monica Lewis (University of Michigan)
*Depth and arithmetic rank*

What is the minimum number of equations needed to cut out a fixed algebraic set in A^n? There is a straightforward way to produce upper bounds on this number: simply try to find a list of equations shorter than the list you started with. However, the task of producing a lower bound is much more difficult. Our goal is to introduce a construction that, in some cases, provides a cohomological obstruction to being 'definable by m equations.' We will introduce the notions of depth and regular sequences, and in some concrete examples, we'll see how an algebraic version of the Mayer-Vietoris sequence can help us use these (seemingly) purely algebraic concepts to attack our original geometric question. We will not assume any background beyond Math 614 and Math 631.
Colloquium Series  
Tuesday, February 05, 2019, 4:00pm-5:00pm  
1360 East Hall  
Melanie Matchett Wood (University of Wisconsin-Madison)  
Random groups from generators and relations

We consider a model of random groups that starts with a free group on n generators and takes the quotient by n random relations. We discuss this model in the case of abelian groups (starting with a free abelian group), and its relationship to the Cohen-Lenstra heuristics, which predict the distribution of class groups of number fields. We will explain a universality theorem, an analog of the central limit theorem for random groups, that says the resulting distribution of random groups is largely insensitive to the distribution from which the relations are chosen. We will discuss joint work with Yuan Liu on the non-abelian random groups built in this way, including the existence of a limit of the random groups as n goes to infinity, as well as theorems about the distribution of non-abelian analogs of class groups of function fields that motivate this work.

Student Machine Learning  
Wednesday, February 06, 2019, 2:30pm-4:00pm  
3866 East Hall  
Brian Chen (UM)  
Deep Feedforward Networks

We begin this chapter with a simple example of a feedforward network. Next, we address each of the design decisions needed to deploy a feedforward network. First, training a feedforward network requires making many of the same design decisions as are necessary for a linear model: choosing the optimizer, the cost function, and the form of the output units. We review these basics of gradient-based learning, then proceed to confront some of the design decisions that are unique to feedforward networks. Feedforward networks have introduced the concept of a hidden layer, and this requires us to choose the activation functions that will be used to compute the hidden layer values. We must also design the architecture of the network, including how many layers the network should contain, how these layers should be connected to each other, and how many units should be in each layer. Learning in deep neural networks requires computing the gradients of complicated functions. We present the back-propagation algorithm and its modern generalizations, which can be used to efficiently compute these gradients. Finally, we close with some historical perspective.
Combinatorics
Wednesday, February 06, 2019, 3:00pm-4:00pm
4088 East Hall
Nati Linial (Hebrew University of Jerusalem)
Graph metrics -- note unusual date!

A finite graph is automatically also a metric space, but is there any interesting geometry to speak of? In this lecture I will try to convey the idea that indeed there is very interesting geometry to explore here. I will say something on the local side of this as well as on the global aspects. The k-local profile of a big graph $G$ is the following distribution. You sample uniformly at random $k$ vertices in $G$ and observe the subgraph that they span. Question - which distributions can occur? We know some of the answer but by and large it is very open. In the global part I concentrate on the question "to what extent can a finite $d$-regular graph resemble the infinite $d$-regular tree"? I will show how this naive-sounding question leads to very difficult and fascinating problems about girth and diameter of large graphs. The lecture will be completely elementary and should be accessible to a broad mathematical audience.

Financial/Actuarial Mathematics
Wednesday, February 06, 2019, 4:00pm-5:00pm
1360 East Hall
Oleksii Mostovyi (UConn)
Optimal consumption from investment and labor income in a unifying framework of admissibility

We consider a problem of optimal consumption from investment and labor income in an incomplete semimartingale market. We introduce a set of constraint times, i.e., a set of stopping times, at which the wealth process must stay positive, in a unifying way such that borrowing against the future income might be allowed or prohibited. Upon this, we increase dimensionality and treat as arguments of the value function not only the initial wealth but also a function that specifies the amount of labor income. Assuming finiteness of the primal and dual value functions and that the labor income is superreplicable (these are essentially the minimal model assumptions), we establish the existence and uniqueness of a solution to the underlying problem and provide several characterizations of the optimizer and the value functions. This talk is based on the joint work with Mihai Sirbu.

RTG Seminar on Geometry, Dynamics and Topology
Wednesday, February 06, 2019, 4:00pm-5:30pm
3866 East Hall
Andy Putman (University of Notre Dame)
The Johnson filtration is finitely generated

The Johnson filtration is an important and mysterious sequence of subgroups of the mapping class group. I will prove that each term is finitely generated once the genus is sufficiently large. The main tool is the Bieri-Neumann-Strebel invariant. No prior knowledge of the mapping class group or the BNS invariant will be assumed. This is joint work with Tom Church and Mikhail Ershov.
Student Arithmetic  
Wednesday, February 06, 2019, 4:00pm-5:00pm  
3088 East Hall  
Yifeng Huang (University of Michigan)  
*Diophantine Equations and Arakelov theory*

Diophantine equations are equations that are looking for solutions in a given number field. Often, these problems can be studied via its completion at various places. One great tool is Arakelov theory, which is aimed to make an analog of intersection theory and Riemann Roch theory in number fields. Time permitting, I will talk about some ideas used in Vojta's proof of Mordell conjecture.

Algebraic Geometry  
Wednesday, February 06, 2019, 4:00pm-5:20pm  
4096 East Hall  
Yongbin Ruan (U Michigan)  
*Verlinde/Grassmanian Correspondence and quantum K-theory*

More than twenty years ago, Witten proposed an equivalence of two quantum fields governing Verlinde algebra (or the theory of stable bundles over a curve) and the quantum cohomology of Grassmanian. Motivated by Witten's physical work and recent revival of quantum K-theory, we proposed a K-theoretic version of so called Verlinde/Grassmanian correspondence. We will first review the new ingredient of level structure in quantum K-theory and surprising appearance of mock theta function. Then, we will present a proof of correspondence in rank two using wall-crossing technique. This is a joint work with Ming Zhang.

Working Group on Anderson Localization  
Wednesday, February 06, 2019, 5:00pm-6:00pm  
4088 East Hall  
Joe Kraisler (University of Michigan)  
*The Anderson Model*

Reading piece: Chapters 2 and 3 of Kirsch.

Topology  
Thursday, February 07, 2019, 3:00pm-4:00pm  
4096 East Hall  
Andy Putman (University of Notre Dame)  
*The stable cohomology of the moduli space of curves with level structures*

I will prove that in a stable range, the rational cohomology of the moduli space of curves with level structures is the same as the ordinary moduli space: a polynomial ring in the Miller-Morita-Mumford classes.
Commutative Algebra  
Thursday, February 07, 2019, 3:00pm-4:00pm  
3866 East Hall  
Monica Lewis ()  
Associated primes and the local cohomology of parameter ideals

The finiteness properties of the local cohomology modules $H^i_I(R)$ when $R$ is a complete intersection are far less well-understood than when $R$ is regular. In 2002, Katzman found that these modules can have infinitely many associated primes, even when $R$ is only a hypersurface. Nonetheless, there are striking finiteness properties that still hold. For example, a 2017 result of Hochster and Nunez-Betancourt shows that the local cohomology of a hypersurface in prime characteristic $p > 0$ will always have finitely many *minimal* associated primes, or equivalently, will have Zariski closed support. It remains an open question whether this property holds for complete intersections cut out by more than one equation. In this talk, we will investigate a closely related question arising from the work Hochster and Nunez-Betancourt: if $J$ is a parameter ideal in a regular ring, is $\text{Ass } H^i_I(J)$ finite? We will establish positive results for certain modules of this form, but will give an example to show that, ultimately, the question has a negative answer.

Differential Equations  
Thursday, February 07, 2019, 4:00pm-5:00pm  
4088 East Hall  
Dana Mendelson (University of Chicago)  
Almost sure wellposedness for some nonlinear dispersive equations

Nonlinear dispersive equations model wave propagation phenomena for many physical systems, from water waves to quantum gases. For the last few decades, research on these equations has centered around questions on the existence of solutions, their long time behavior, and the possibility of singularity formation. Fundamental progress has been made in many settings, yet in some regimes, the nonlinear interactions overwhelm the dispersion of the waves, and standard methods break down.

In recent years, probabilistic tools have been instrumental in analyzing the behavior of these equations in previously inaccessible regimes.

In this talk, I will discuss several problems concerning nonlinear wave and dispersive equations with random initial data, including the energy critical nonlinear wave and Schroedinger equations, and derivative nonlinear wave equations. I will present several almost sure well-posedness and scattering results for these equations and contrast the ways in which random data techniques can be exploited in these different contexts.
Let $X$ be a smooth projective variety over the complex numbers. One way to study $X$ is to examine the “positive” divisors that it admits; more precisely, one can consider the cones (in the Neron-Severi space of $X$) that are spanned by classes of ample or effective divisors. This leads to more subtle notions of positivity, e.g. nef, big, and pseudoeffective divisors. We will discuss how the positivity of divisors informs the geometry of $X$.

Interactions of vortex structures play an important role in the understanding of complex evolutions of fluid flows. Incompressible and inviscid flows with point-wise vorticity distributions in two-dimensional space, called point vortices, have been used as a theoretical model to describe such vortex interactions. The motion of point vortices has been investigated well in unbounded planes with boundaries as well as on a sphere owing to their physical relevance. On the other hand, it is of a theoretical interest to investigate how geometric nature of curved surfaces and the number of holes gives rise to different vortex interactions that are not observed in vortex dynamics in the plane and on the sphere. In this talk, we consider the dynamics of point vortices on a toroidal surface, which is a compact, orientable 2D Riemannian manifold with a non constant curvature with a handle structure. Deriving the equation of motion of point vortices, we obtain some stationary point-vortex configurations and describe the interactions of two point vortices in order to cultivate an insight into vortex interactions on this manifold. We will also discuss the stability of the ring configuration of $N$ point vortices aligned along the line of latitude.
Combinatorics
Friday, February 08, 2019, 3:00pm-4:00pm
4088 East Hall
Melissa Sherman-Bennett (UC Berkeley)
Combinatorics of cluster structures in Schubert varieties

The (affine cone over the) Grassmannian is a prototypical example of a variety with “cluster structure”; that is, its coordinate ring is a cluster algebra. Scott (2006) gave a combinatorial description of this cluster algebra in terms of Postnikov's plabic graphs. It has been conjectured essentially since Scott's result that Schubert varieties also have a cluster structure with a description in terms of plabic graphs. I will discuss recent work with K. Serhiyenko and L. Williams proving this conjecture. The proof uses a result of Leclerc, who shows that many Richardson varieties in the full flag variety have cluster structure using cluster-category methods, and a construction of Karpman to build plabic graphs for each Schubert variety.

Student AIM Seminar
Friday, February 08, 2019, 4:00pm-5:00pm
1084 East Hall
Christiana Mavroyiakoumou (University of Michigan)
The Ekman spiral and point vortex motion around boundaries

In this talk, I will present one of my favorite phenomena from geophysical fluid dynamics: the Ekman spiral. It can be thought of as a "spiral staircase down into the depths of the ocean". This is not only a fascinating oceanic phenomenon in itself, but also has far reaching effects on many coasts. The way the Ekman spiral transports water, known as upwelling, has a large influence on the life in the affected regions of the ocean. If time permits, I will also talk about vortex motion with boundaries (Kirchhoff-Routh theory) and extensions of this to multiply connected geometries.