Monday, March 19, 2018

4:00pm-5:00pm  **Complex Analysis, Dynamics and Geometry** -- Nyima Kao (UChicago) *The Manhattan Curve for Hyperbolic Surfaces with Cusps* -- 3096 East Hall

4:00pm-5:00pm  **Integrable Systems and Random Matrix Theory** -- Hao Wu (University of Michigan) *The Periodic Aztec Diamond - Take II* -- 1866 East Hall

4:00pm-5:00pm  **Student Combinatorics Seminar** -- Viswambhara Makam (University of Michigan) *The combinatorics of polarization* -- 3866 East Hall

4:10pm-5:00pm  **Group, Lie and Number Theory** -- Stefan Papatakis (University of Utah) *Lifting Galois representations with (somewhat) small image* -- 4088 East Hall

5:15pm-6:30pm  **Teaching Mathematics** -- Vilma Mesa (Univ Michigan School of Education) *Design and Use of Open Source Mathematics Textbooks with Embedded Computation* -- 3866 East Hall

Tuesday, March 20, 2018

3:00pm-4:00pm  **Student Geometry/Topology** -- (No talk this week) -- 3866 East Hall

3:00pm-4:00pm  **Student Representation Theory** -- Bob Lutz (University of Michigan) *Specht matroids and polytopes* -- 1866 East Hall

4:10pm-5:00pm  **Colloquium Series** -- Richard Taylor (Institute for Advanced Study) *Arithmetic and locally symmetric spaces* -- 1360 East Hall

Wednesday, March 21, 2018

3:00pm-4:00pm  **Student Arithmetic** -- Yifeng Huang (UM) *Introduction to Iwasawa theory - Weak Leopoldt conjecture for cyclotomic Zp-extensions* -- 1866 East Hall

4:00pm-5:00pm  **Financial/Actuarial Mathematics** -- Parsiad Azimzadeh (UM) *Convergence of implicit schemes for Hamilton-Jacobi-Bellman quasi-variational inequalities* -- B844 East Hall

4:10pm-5:00pm  **Special Events** -- Richard Taylor (Institute for Advanced Study) *Rainich Lecture: Galois theory and locally symmetric spaces* -- 1360 East Hall

Thursday, March 22, 2018

3:00pm-4:00pm  **Topology** -- Johanna Mangahas (University at Buffalo) *Right-angled Artin groups as normal subgroups of mapping class groups* -- 1866 East Hall

3:00pm-4:00pm  **Commutative Algebra** -- Claudia Polini (University of Notre Dame) *Simple D-module components of local cohomology modules* -- B735 East Hall

4:00pm-5:00pm  **Differential Equations** -- Andre Martinez-Finkelshtein (Baylor) *Multiple non-hermitian orthogonality and vector electrostatics: results, connections and problems* -- 4088 East Hall

4:00pm-5:00pm  **Student Dynamics** -- Kostas Tsouvalas (University of Michigan) *Projective Anosov representations* -- 1866 East Hall

4:10pm-5:00pm  **Special Events** -- Richard Taylor (Institute for Advanced Study) *Rainich Lecture: Modularity lifting theorems in the setting of locally symmetric spaces* -- 1360 East Hall
<table>
<thead>
<tr>
<th>Time</th>
<th>Event</th>
<th>Location</th>
</tr>
</thead>
<tbody>
<tr>
<td>10:00am-11:00am</td>
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</tr>
<tr>
<td>12:10pm-2:00pm</td>
<td><strong>Student Homotopy Theory</strong> -- David Schwein (University of Michigan) <em>Model Categories</em></td>
<td>1360 East Hall</td>
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<td><strong>Applied Interdisciplinary Mathematics (AIM)</strong> -- Andrei Martinez-Finkelshtein (Baylor University) <em>Math is in the eye of the beholder</em></td>
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</tr>
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<td>1096 East Hall</td>
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<td><strong>Combinatorics</strong> -- Anna Weigandt (UIUC) <em>Partition Identities and Quiver Representations</em></td>
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<td>4:10pm-5:00pm</td>
<td><strong>Student AIM Seminar</strong> -- Amanda Bower (University of Michigan) <em>The Landscape of Non-Convex Quadratic Feasibility</em></td>
<td>1084 East Hall</td>
</tr>
<tr>
<td>4:10pm-5:30pm</td>
<td><strong>Preprint Algebraic Geometry Seminar</strong> -- Kannappan Sampath (UM) <em>The failure of Kodaira vanishing for Fano varieties, and terminal singularities that are not Cohen-Macaulay (following Totaro)</em></td>
<td>4096 East Hall</td>
</tr>
</tbody>
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Complex Analysis, Dynamics and Geometry  
**Monday, March 19, 2018, 4:00pm-5:00pm**  
3096 East Hall  
Nyima Kao (UChicago)  
*The Manhattan Curve for Hyperbolic Surfaces with Cusps*

In this talk, we will discuss an interesting curve, so-called the Manhattan curve, associated with a pair of boundary-preserving Fuchsian representations of a (non-compact) surface, especially representations corresponding to Riemann surfaces with cusps. Marc Burger and Richard Sharp showed that, for convex-cocompact Fuchsian representations, one can use the shape of the Manhattan curve to derive dynamical and geometric rigidity results. We will discuss how the Thermodynamic Formalism (for countable Markov shifts) helps us to generalize these rigidity results to non-convex-cocompact Fuchsian representations.

Integrable Systems and Random Matrix Theory  
**Monday, March 19, 2018, 4:00pm-5:00pm**  
1866 East Hall  
Hao Wu (University of Michigan)  
*The Periodic Aztec Diamond - Take II*

The problem of tiling a given planar region is quite classical. A more modern approach is to consider the tilings of a given region under the light of statistical mechanics: given a measure on all possible tiling configurations of a large planar region, can we say how a "typical" tiling looks like? In this series of talks, we consider this problem when the region is the aztec diamond, and the tilings are dominos, distributed in a periodic fashion. It turns out that this model displays a quite rich, yet explicit, structure, and we plan to survey in details some recent developments in this model.
Student Combinatorics Seminar
Monday, March 19, 2018, 4:00pm-5:00pm
3866 East Hall
Viswambhara Makam (University of Michigan)

The combinatorics of polarization

The representation theory of GL(n) is very well understood in characteristic 0. Associated to each partition of length at most n, there is an irreducible representation of GL(n). There are several functorial ways to construct the irreducible representations. In positive characteristic, each of these constructions will still yield a representation of GL(n). However, they will not in general be irreducible, nor will the different constructions agree. We will consider the Schur module construction. In trying to prove a version in positive characteristic of the famous theorem of Weyl on polarization, we will run into an interesting combinatorial question on Schur modules. I expect that there should be more applications to this result. This is joint work with Derksen.

Group, Lie and Number Theory
Monday, March 19, 2018, 4:10pm-5:30pm
4088 East Hall
Stefan Patrikis (University of Utah)

Lifting Galois representations with (somewhat) small image

A basic question in the spirit of Serre's modularity conjecture is when (or whether) a mod p Galois representation can be lifted to a geometric p-adic representation. Two basic techniques are available: the first comes from applying potential automorphy and automorphy lifting theorems, and gives the most robust results for Galois representations valued in certain classical groups; the second is a purely Galois-theoretic method, originally developed by Ravi Ramakrishna, that applies more readily to general groups. In this talk I will discuss some new techniques in the spirit of Ramakrishna's work. This is joint work with Najmuddin Fakhruddin and Chandrashekhar Khare.
Teaching Mathematics  
Monday, March 19, 2018, 5:15pm-6:30pm  
3866 East Hall  
Vilma Mesa (Univ Michigan School of Education)  
*Design and Use of Open Source Mathematics Textbooks with Embedded Computation*

In this talk we report on ongoing work that supports the development of tools for authors to produce open source mathematics textbooks that embed computation, with Sage. The textbooks operate with an open license and are usually distributed at a very low cost to students. In addition we report on efforts to understand how faculty and students use two of these textbooks, one on linear algebra and the other on abstract algebra, taking advantage of the minute-by-minute data that can be collected.

Robert Beezer is Professor of Mathematics, University of Puget Sound. Beezer has 38 years teaching experience, is an open textbook author, and a Sage developer.

Vilma Mesa is at the school of education and these days tries to stay afloat among the many fun projects she is running (from).

Student Geometry/Topology  
Tuesday, March 20, 2018, 3:00pm-4:00pm  
3866 East Hall  

*No talk this week*

Student Representation Theory  
Tuesday, March 20, 2018, 3:00pm-4:00pm  
1866 East Hall  
Bob Lutz (University of Michigan)  
*Specht matroids and polytopes*

One construction of the finite-dimensional irreducible representations of $S_n$ uses combinatorial spanning sets introduced by W. Specht. Each spanning set satisfies intricate linear relations, which are encoded by a so-called Specht matroid. One can visualize any such matroid as the convex hull of the associated spanning set, called the Specht polytope. We will discuss Specht matroids and polytopes and see how they encode combinatorial information about the underlying representations. No prior knowledge of matroids will be assumed.
Langlands proposed an extraordinary correspondence between representations of Galois groups and automorphic forms, which has deep, and completely unexpected, implications for the study of both objects. The simplest special case is Gauss' law of quadratic reciprocity. In the so called `regular, self-dual' case much progress has been made in the roughly 40 years since Langlands made these conjectures. In these talks I will discuss recent progress in regular, but non-self-dual case. In this case the automorphic forms in question can be realized as cohomology classes for arithmetic locally symmetric spaces, i.e., quotients of symmetric spaces by discrete groups. Thus instead of the Langlands correspondence being a relationship between algebra and analysis, it can be thought of as a relationship between algebra and topology. This realization of the Langlands correspondence is in many ways more concrete. It also admits to generalizations not envisioned by Langlands, for instance relating mod p Galois representations with mod p cohomology classes.

In these talks I will describe the expected Langlands correspondence in the special cases of modular curves (an example of the `self-dual' case) and arithmetic hyperbolic 3-manifolds (an example of the `non-self-dual' case). I will try both to present the general picture and to give numerical examples. I will also describe various recent theorems in the latter case due to Lan, Harris, Thorne and myself; to Peter Scholze; and to Allen, Calegari, Caraiani, Gee, Helm, Le Hung, Newton, Scholze, Thorne and myself.

Reception for the Speaker will follow at 5:00PM in the Upper Atrium, East Hall on March 20, 2018

Sponsored by the Rainich Lecture Series
Student Arithmetic
Wednesday, March 21, 2018, 3:00pm-4:00pm
1866 East Hall
Yifeng Huang (UM)

*Introduction to Iwasawa theory - Weak Leopoldt conjecture for cyclotomic Zp-extensions*

A Zp-extension of a number field is an extension whose Galois group is isomorphic to Zp, and it naturally gives rise to a tower of Z/p^n extensions of number fields. Iwasawa theory originally studies the ideal class groups of the fields in such a tower, via the study of certain Galois groups that have natural Zp[[T]]-module structures. The weak Leopoldt conjecture is a statement about the asymptotic behavior of some Galois Zp-modules associated to each layer of the tower. Here, we will discuss some basic terminologies and facts about Zp-extensions and Zp[[T]]-modules to understand the statement of weak Leopoldt conjecture. If time permits, we will discuss the idea from Kummer theory to verify this conjecture for Zp-extensions obtained from adjoining p-th power roots of unity.

Financial/Actuarial Mathematics
Wednesday, March 21, 2018, 4:00pm-5:00pm
B844 East Hall
Parsiad Azimzadeh (UM)

*Convergence of implicit schemes for Hamilton-Jacobi-Bellman quasi-variational inequalities*

In [Azimzadeh, P., and P. A. Forsyth. "Weakly chained matrices, policy iteration, and impulse control." SIAM J. Num. Anal. 54.3 (2016): 1341-1364], we outlined the theory and implementation of computational methods for implicit schemes for Hamilton-Jacobi-Bellman quasi-variational inequalities. No convergence proofs were given therein. This work closes the gap by giving rigorous proofs of convergence. A point of difficulty in the analysis is that a standard application of the Barles-Souganidis framework (BSF) requires a stronger comparison principle than that which is available in the literature. By introducing a stronger notion of consistency than that which is posed in the BSF, we are able to prove convergence relying only on a well-known comparison principle. Our results are robust in that we do not assume a specific form for the intervention operator.

Joint work with Erhan Bayraktar and George Labahn.
Langlands proposed an extraordinary correspondence between representations of Galois groups and automorphic forms, which has deep, and completely unexpected, implications for the study of both objects. The simplest special case is Gauss' law of quadratic reciprocity. In the so called 'regular, self-dual' case much progress has been made in the roughly 40 years since Langlands made these conjectures. In these talks I will discuss recent progress in regular, but non-self-dual case. In this case the automorphic forms in question can be realized as cohomology classes for arithmetic locally symmetric spaces, i.e., quotients of symmetric spaces by discrete groups. Thus instead of the Langlands correspondence being a relationship between algebra and analysis, it can be thought of as a relationship between algebra and topology. This realization of the Langlands correspondence is in many ways more concrete. It also admits to generalizations not envisioned by Langlands, for instance relating mod p Galois representations with mod p cohomology classes.

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Sponsored by the Rainich Lecture Series

Topology
Thursday, March 22, 2018, 3:00pm-4:00pm
1866 East Hall
Johanna Mangahas (University at Buffalo)
Right-angled Artin groups as normal subgroups of mapping class groups

Free normal subgroups of mapping class groups abound, by the result of Dahmani, Guirardel, and Osin that the normal closure of high powers of pseudo-Anosovs is free. At the other extreme, if a normal subgroup contains a mapping class supported on too small a subsurface, it can never be isomorphic to a right-angled Artin group, by work of Brendle and Margalit. I will talk about a case right in between: a family of normal subgroups isomorphic to non-free right-angled Artin groups. We also recover, expand, and make constructive the result of Dahmani, Guirardel, and Osin about free normal subgroups. We do this by creating a version of their "windmill" construction tailor-made for the projection complexes introduced by Bestvina, Bromberg, and Fujiwara. This is joint work with Matt Clay and Dan Margalit.
Commutative Algebra  
Thursday, March 22, 2018, 3:00pm-4:00pm  
B735 East Hall  
Claudia Polini (University of Notre Dame)  
*Simple D-module components of local cohomology modules*

A long standing problem in algebraic geometry and commutative algebra is to determine whether every irreducible curve in projective three-space is a set-theoretic complete intersection. One way to approach this problem is via the study of local cohomology modules. As modules over the ring, local cohomology modules are huge (neither finitely generated nor Artinian), hence intractable. However, as modules over the Weil algebra D they can be filtered by simple objects and become manageable. Hence an important task is to understand the D-module structure of local cohomology modules. In this talk we describe their composition series. This is joint work with Robin Hartshorne. Time permitting I would like to talk about two generalizations of this work, one done by Wenliang Zhang and Nicholas Switala, and one by Gennady Lyubeznik.

Differential Equations  
Thursday, March 22, 2018, 4:00pm-5:00pm  
4088 East Hall  
Andre Martinez-Finkelshtein (Baylor)  
*Multiple non-hermitian orthogonality and vector electrostatics: results, connections and problems*

This talk is a sampler of some recent results (in great part, in collaboration with Guilherme Silva), some work in progress, and some open problems related to the multiple (or Hermite-Pade) non-hermitian orthogonality. It appears naturally in many situations, and the asymptotic properties of the corresponding orthogonal polynomials is closely connected to certain vector equilibrium problems on the plane.

Student Dynamics  
Thursday, March 22, 2018, 4:00pm-5:00pm  
1866 East Hall  
Kostas Tsouvalas (University of Michigan)  
*Projective Anosov representations*

Anosov representations have been introduced by Labourie and generalize convex cocompact representations of word hyperbolic groups into rank one Lie groups. In this talk, we will introduce a specific class of Anosov representations called Projective Anosov representations and give their main properties. It follows by Benoist's work that discrete subgroups of the (real) projective linear group which divide strictly convex domains of the associated real projective space give rise to such representations. We will also explain why this class of examples are Projective Anosov.
Calegari and Geraghty described an approach to modularity lifting theorems in the setting of locally symmetric spaces, where the basic numerology of the Taylor-Wiles method seemed to break down. A group of 10 mathematicians (Allen, Calegari, Caraiani, Gee, Helm, Le Hung, Newton, Scholze, Thorne and myself) were recently able to get this approach to work, the key ingredient being to systematically work in a derived framework. As applications we were able to prove the meromorphic continuation and functional equation of the \( L \)-series of elliptic curves over CM fields and to prove the Ramanujan conjecture for the action of Hecke operators on the cohomology of arithmetic hyperbolic three manifolds. I will describe these results and give an outline of the proof.

Sponsored by the Rainich Lecture Series

**Symplectic Reading Group**

*Friday, March 23, 2018, 10:00am-11:00am*

1360 East Hall

Alejandro Uribe (UM)

*An overview of geometric quantization (2)*

Continued from March 16: see the abstract from that date.

**Student Homotopy Theory**

*Friday, March 23, 2018, 12:10pm-2:00pm*

1360 East Hall

David Schwein (University of Michigan)

*Model Categories*

In the 1960's, Quillen unearthed a common structure underlying homological algebra and the homotopy theory of topological spaces: the model category, a general, abstract, category-theoretic framework for homotopy theory, or as Quillen called it, homotopical algebra. After defining a model category and giving basic examples, we will describe the homotopy theory of a model category and, time permitting, explain how model categories give rise to derived functors (generalizing the classical derived functors of homological algebra) and provide a conceptual framework for homotopy limits and colimits.
Applied Interdisciplinary Mathematics (AIM)
Friday, March 23, 2018, 3:00pm-4:00pm
1084 East Hall
Andrei Martinez-Finkelshtein (Baylor University)

Math is in the eye of the beholder

Medical imaging benefits from advances in constructive approximation, orthogonal polynomials, Fourier and numerical analysis, statistics and other branches of mathematics. At the same time, the needs of medical diagnostic technology pose new mathematical challenges. This talk surveys a few problems, some of them related to approximation theory, that have appeared in my collaboration with specialists studying some pathologies of the human eye, in particular, of the cornea, such as:
- reconstruction of the shape of the cornea from the data collected by keratoscopes
- implementation of simple indices of corneal irregularity
- fast and reliable computation of the through-focus characteristics of a human eye.

Geometry
Friday, March 23, 2018, 3:00pm-4:00pm
3866 East Hall
Becca Winarski (UWisconsin-Milwaukee)

Twisted Rabbits and Hubbard Trees

The twisted rabbit problem is a celebrated problem in complex dynamics. Work of William Thurston proves that up to equivalence, there are exactly three branched coverings of the sphere to itself satisfying certain conditions. When one of these branched coverings is modified by a mapping class, a map equivalent to one of the three coverings results. Which one?

After remaining open for 25 years, this problem was solved by Bartholdi-Nekyrashevych using iterated monodromy groups. In joint work with Belk, Lanier and Margalit, we formulate the problem topologically and solve the problem using Hubbard trees.

Special Events
Friday, March 23, 2018, 3:00pm-5:00pm
1096 East Hall
Scott Rich (UM)

Graduate Thesis Defense
Student Algebraic Geometry  
Friday, March 23, 2018, 3:10pm-4:00pm  
3096 East Hall  
Shubhodip Mondal (UM)  
*Witt vectors and deformations*

We will define Witt vectors as some sort of "arithmetic deformations". Time permitting we will talk about liftable/nonliftable algebras defined over $\mathbb{F}_p$. This talk will be accessible to anyone who is in or has taken 632.

Combinatorics  
Friday, March 23, 2018, 4:00pm-5:00pm  
4088 East Hall  
Anna Weigandt (UIUC)  
*Partition Identities and Quiver Representations*

We present a particular connection between classical partition combinatorics and the theory of quiver representations. Specifically, we generalize the Durfee square identity to multipartitions and give a bijective proof. We then apply this result to obtain a new proof of Reineke's quantum dilogarithm identities in type A. This is joint work with R. Rimányi and A. Yong.
Traditionally, a non-convex problem is oftentimes solved by solving a convex approximation since finding the global minimizer of a convex problem is theoretically efficient. Unfortunately, there can be a mismatch between practice and theory since the convex optimization approach can be practically slow. On the other hand, solving the original non-convex problem directly can be much faster in practice although in general, it is unclear whether these methods succeed since non-convex functions can have many saddle points and local minima.

Recently, researchers have closed the gap theoretically in understanding why solving non-convex problems directly reliably finds the global minimum. Under appropriate assumptions, in many important problems--like in matrix completion and simple neural networks--the reason for success is because every local minimum is a global minimum.

Motivated by this success and applications such as ordinal embedding and collaborative ranking, in this talk, we formulate homogeneous quadratic feasibility as an unconstrained, non-convex minimization problem and aim to understand the landscape (local minimizers and global minimizers) of the non-convex objective since the efficacy of applying a first-order method like stochastic gradient descent hinges on the landscape. The only prerequisite of this talk is calculus.

Preprint Algebraic Geometry Seminar
Friday, March 23, 2018, 4:10pm-5:30pm
4096 East Hall
Kannappan Sampath (UM)

The failure of Kodaira vanishing for Fano varieties, and terminal singularities that are not Cohen-Macaulay (following Totaro)

http://front.math.ucdavis.edu/1710.04364