# Weekly Seminar & Events Bulletin
## April 3rd, 2022 - April 9th, 2022

### Monday, April 04, 2022

<table>
<thead>
<tr>
<th>Time</th>
<th>Event</th>
<th>Speaker</th>
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<tbody>
<tr>
<td>3:00pm-4:00pm</td>
<td><strong>RTG Seminar on Number Theory</strong> -- Tian An Wong (University of Michigan-Dearborn) <em>Weighting the Arthur-Selberg trace formula</em></td>
<td>4088 East Hall</td>
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### Tuesday, April 05, 2022

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<td>2:30pm-4:00pm</td>
<td><strong>Learning Seminar in Algebraic Combinatorics</strong> -- George Seelinger (University of Michigan) <em>Braid Varieties II</em></td>
<td>4096 East Hall</td>
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<td>4:00pm-5:20pm</td>
<td><strong>Algebraic Geometry</strong> -- Emelie Arvidsson (IAS) <em>Vanishing theorems for Fano's and depth of klt and lc singularities in positive characteristics</em></td>
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<td>4:00pm-5:30pm</td>
<td><strong>RTG Seminar on Geometry, Dynamics and Topology</strong> -- Shreyasi Datta (U Michigan) <em>Singular vectors in affine subspaces</em></td>
<td>3866 East Hall</td>
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<td>5:15pm-6:15pm</td>
<td><strong>Student Analysis</strong> -- Zachary Deiman (University of Michigan) <em>Introduction to Fractional Differential Equations</em></td>
<td>3096 East Hall</td>
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### Thursday, April 07, 2022

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<tr>
<td>9:00am-10:00am</td>
<td><strong>Variational Analysis and Optimization</strong> -- Peter Wolenski (Louisiana State University) <em>Optimal Control with piecewise constant dynamics</em></td>
<td>Virtual</td>
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<tr>
<td>1:00pm-2:30pm</td>
<td><strong>Teaching Mathematics</strong> -- LCIT Discussion () <em>Discussion</em></td>
<td>4866 East Hall</td>
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<tr>
<td>4:00pm-5:30pm</td>
<td><strong>Arithmetic Geometry Learning</strong> -- James Hotchkiss () <em>Degeneration method without resolutions and stably irrational hypersurfaces</em></td>
<td>4096 East Hall</td>
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<td>4:00pm-5:00pm</td>
<td><strong>Commutative Algebra</strong> -- Justin Lyle (University of Arkansas ) <em>Generalizations of Ulrich Modules</em></td>
<td>Virtual East Hall</td>
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<td>4:00pm-5:30pm</td>
<td><strong>Logic</strong> -- Iian Smythe (UM) <em>Equivalence of generic reals (Part 2)</em></td>
<td>2866 East Hall</td>
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<td>5:30pm-6:30pm</td>
<td><strong>Special Events</strong> -- Paul Kessenich (UM) <em>Jobs in Academia for Mathematicians Workshop - Teaching statements</em></td>
<td>3866 East Hall</td>
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<td>1:00pm-2:00pm</td>
<td><strong>Representation Stability</strong> -- Nir Gadish (University of Michigan) <em>Is there representation stability in high dimensional cohomology of moduli spaces of curves?</em> -- Online</td>
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<td>3:00pm-4:00pm</td>
<td><strong>Student Algebraic Geometry</strong> -- Saket Shah (UM) <em>27 Lines on a Cubic Surface</em> -- 2866 East Hall</td>
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<td><strong>Applied Interdisciplinary Mathematics (AIM)</strong> -- David Bindel (Cornell University) <em>The Structure and Interpretation of Graph Spectral Densities</em> -- Virtual</td>
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<td>4:00pm-4:50pm</td>
<td><strong>Learning Seminar in Representation Stability</strong> -- Karol Koziol (UM) <em>Morita theory</em> -- 1866 East Hall</td>
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<td>4:00pm-5:00pm</td>
<td><strong>Student AIM Seminar</strong> -- Alexander Ginsberg (University of Michigan) <em>Modeling Networks of Neurons in the Spinal Cord to Understand How Electrical Stimulation Can Alleviate Chronic Pain</em> -- 2866 East Hall</td>
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<td>4:00pm-5:30pm</td>
<td><strong>Preprint Algebraic Geometry</strong> -- Lena Ji (UM) <em>The Lipman-Zariski conjecture, part II</em> -- 4096 East Hall</td>
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Abstracts for the week of April 3rd, 2022 - April 9th, 2022

RTG Seminar on Number Theory
Monday, April 04, 2022, 3:00pm-4:00pm
4088 East Hall
Tian An Wong (University of Michigan-Dearborn)

Weighting the Arthur-Selberg trace formula

An important problem in the study of the Arthur-Selberg trace formula is to weight the spectral side of with data related to automorphic L-functions, and to obtain a parallel geometric expansion. One such method is the use of certain basic functions, and work of Finis-Lapid-Müller allows for their use in the noninvariant trace formula. In this talk, I will motivate this problem from the point of view of what might be called "classical" beyond endoscopy, and discuss the extension of the latter results to the invariant and stable trace formulas. Time permitting, I will explain how this translates the problem of meromorphic continuation of automorphic L-functions to that of zeta functions of prehomogeneous vector spaces.

RTG Representation Theory
Monday, April 04, 2022, 4:00pm-5:15pm
4088 East Hall
Andy Gordon (UM)

Geometric Satake for SL2
Integrable Systems and Random Matrix Theory
Monday, April 04, 2022, 4:00pm-5:00pm
ZOOM ID: 926 6491 9790 Virtual
Giorgio Young (Rice University)
*Uniqueness of solutions of the KdV-hierarchy via Dubrovin-type flows*

We consider the Cauchy problem for the KdV hierarchy -- a family of integrable PDEs with a Lax pair representation involving one-dimensional Schrodinger operators -- under a local in time boundedness assumption on the solution.

For reflectionless initial data, we prove that the solution stays reflectionless. For almost periodic initial data with absolutely continuous spectrum, we prove that under Craig-type conditions on the spectrum, Dirichlet data evolve according to a Lipschitz Dubrovin-type flow, so the solution is uniquely recovered by a trace formula. This applies to algebro-geometric (finite gap) solutions; more notably, we prove that it applies to small quasiperiodic initial data with analytic sampling functions and Diophantine frequency. This also gives a uniqueness result for the Cauchy problem on the line for periodic initial data, even in the absence of Craig-type conditions. This is joint work with Milivoje Lukić.

<A recording of the talk can be found <a href="https://youtu.be/5qcxmuShBjg">here</a>.<b/>

Complex Analysis, Dynamics and Geometry
Monday, April 04, 2022, 4:00pm-5:00pm
3096 East Hall
Howard Masur (University of Chicago)
*Counting pairs of saddle connections on translation surfaces*

A translation surface can be thought of as a polygon in the plane with pairs of sides identified by parallel translation. A saddle connection is a straight line joining the vertices of the polygon. It determines a vector in the plane. The problem of the asymptotics of the number of saddles less than a given length was initiated by W.Veech. I will recall some of the known results in this subject. I will then discuss the problem of counting pairs of saddle connections. The motivation is in part a result of J. Smillie and B. Weiss who showed that for a Veech or lattice surface there are no small (virtual) area triangles so any pair of saddle connections with small cross product are parallel. I will discuss for a generic surface the asymptotics of the number of pairs of saddle connections which have a bound on their cross product. This is joint work with Jayadev Athreya and Samantha Fairchild.
Student Combinatorics
Monday, April 04, 2022, 4:00pm-5:00pm
3866 East Hall
Mia Smith (UM)

*Szemerédi's Regularity Lemma and its Applications*

Szemerédi's regularity lemma is a powerful statement about the randomness of large dense graphs. Roughly speaking, it says that the vertices of every large enough graph can be partitioned into a bounded number of parts so that between two parts the edges behave almost randomly. Although most commonly used as a tool in extremal graph theory, it has some elegant applications to other areas of extremal combinatorics.

In this talk, we will explore its application to Roth's Theorem, a statement about the existence of arithmetic progressions in sets with positive upper density.

Student Commutative Algebra
Tuesday, April 05, 2022, 3:00pm-4:00pm
3088 East Hall
Havi Ellers (University of Michigan, Ann Arbor)

*Zariski's Cancellation Problem*

First proposed in 1971, the Cancellation Problem asks whether \( A[X_1,...,X_n] \) isomorphic to \( B[Y_1,...,Y_n] \) for rings \( A \) and \( B \) implies that \( A \) is isomorphic to \( B \). In this talk we discuss a counterexample to the Cancellation Problem, a variant of the problem which holds, and a couple of modern results in the same genre.

Topology
Tuesday, April 05, 2022, 3:00pm-4:00pm
1866 East Hall
Howard Masur (University of Chicago)

*Hyperbolicity of the curve complex and a few of its applications*

This is meant to be an expository talk.

Please note the unusual room: EH 1866.
Colloquium Series
Tuesday, April 05, 2022, 4:00pm-5:00pm
1360 East Hall
Aaron Pixton (University of Michigan)
The double ramification cycle formula

The double ramification cycle parametrizes algebraic curves (or Riemann surfaces) of genus g admitting maps to the projective line (or Riemann sphere) with specified branching over two points. I'll describe a formula giving the class of this cycle in the cohomology of the moduli space of curves. I'll then discuss some of the combinatorial features of this formula and how they relate back to geometry.

Financial/Actuarial Mathematics
Wednesday, April 06, 2022, 2:30pm-4:00pm
2866 East Hall
April Nellis (UM)
A neural network approach to high-dimensional optimal switching problems with jumps in energy markets

We consider optimal switching problems represented by a coupled system of forward-backward stochastic differential equations, in which finite-variational jumps in the forward process drive jumps in the backward process representing the value function associated with the switching problem. We subsequently develop a backward-in-time machine learning algorithm that uses a sequence of neural networks and the dynamic programming principle to solve for optimal switching strategies, where the neural network is able to learn to account for the jumps present in the problem. We then apply this algorithm to a variety of problems arising from energy production and scheduling problems, and find that the algorithm performs with accuracy and experiences only minimal slowdowns as dimension increases.

Learning Seminar in Algebraic Combinatorics
Wednesday, April 06, 2022, 2:30pm-4:00pm
4096 East Hall
George Seelinger (University of Michigan)
Braid Varieties II

Continuing our discussion of braid varieties, we will examine how to construct a braid variety corresponding to braid words with negative crossings, allowing more flexibility in our computations. Furthermore, equipped with this new description, we will discuss when positroid varieties and braid varieties coincide.

References: https://arxiv.org/abs/2105.13948
Algebraic Geometry  
Wednesday, April 06, 2022, 4:00pm-5:20pm  
4096 East Hall  
Emelie Arvidsson (IAS)  
*Vanishing theorems for Fano’s and depth of klt and lc singularities in positive characteristics*

In this talk I will discuss a conjecture on vanishing theorems for Fano’s in positive characteristic.

I will report on what I know about the progress on the problem, including the solution in dimension two (joint work with J. Lacini and F. Bernasconi). Finally, I will discuss the relationship (due to C. Hacon and J. Witaszek) between this vanishing theorem and the depth of klt singularities and explain how similar ideas can be used to construct a three-dimensional log-canonical singularity which contradicts a theorem of Kollár over the complex numbers in every positive characteristic. This example is part of a joint work in progress with F. Bernasconi and Z. Patakfalvi.

RTG Seminar on Geometry, Dynamics and Topology  
Wednesday, April 06, 2022, 4:00pm-5:30pm  
3866 East Hall  
Shreyasi Datta (U Michigan)  
*Singular vectors in affine subspaces*

A theme of Diophantine approximation is to see if a Diophantine property gets inherited by a sub-manifold from its ambient affine subspace. We will talk about one such property, called as singularity of vectors, in case of sub-manifolds of $\mathbb{R}^n$ and function field over finite fields. One reason why singular vectors are an interesting object of study is their connection with homogeneous dynamics, in particular they correspond to some divergent orbits. The talk will be based on a joint work with Yewei Xu, who was my REU student in last summer.

Student Analysis  
Wednesday, April 06, 2022, 5:15pm-6:15pm  
3096 East Hall  
Zachary Deiman (University of Michigan)  
*Introduction to Fractional Differential Equations*

Fractional calculus is an area of analysis that aims to generalize the derivative and integral operators to fractional order. These fractional operators are collectively known as differintegrals, and they naturally lead to the idea of fractional differential equations. Such equations have several applications in solving engineering and physics problems. In this talk, we will introduce some basic fractional differential equations and discuss methods for solving them. We will also use differintegrals to derive a formula for the heat flux for a certain diffusion problem. Time permitting, we will show how differintegrals can be used to find solutions for ordinary differential equations.
Teaching Mathematics  
**Thursday, April 07, 2022, 1:00pm-2:30pm**  
4866 East Hall  
LCIT Discussion ()  
*Discussion*

Arithmetic Geometry Learning  
**Thursday, April 07, 2022, 4:00pm-5:30pm**  
4096 East Hall  
James Hotchkiss ()  
*Degeneration method without resolutions and stably irrational hypersurfaces*

Commutative Algebra  
**Thursday, April 07, 2022, 4:00pm-5:00pm**  
[https://umich.zoom.us/j/96274532499 (password: algebra) Virtual East Hall](https://umich.zoom.us/j/96274532499)  
Justin Lyle (University of Arkansas)  
*Generalizations of Ulrich Modules*

Abstract: Let $R$ be a local ring. A finitely generated $R$-module $M$ is said to be Ulrich if it is maximal Cohen-Macaulay and if its Hilbert-Samuel multiplicity is equal to its minimal number of generators. These modules have rich properties, and their existence has deep consequences for the base ring $R$. However, recent work of Yhee shows they need not exist in general, and the situations where they are known to exist are quite sparse. It is thus natural to look for weaker conditions which still retain some of the desired properties of Ulrich modules. In this talk, we will discuss several ways one can meaningfully relax the Ulrich condition. We will overview various properties enjoyed by these generalizations as well as some cases where existence can be established. This is based on joint work with Olgur Celikbas, Ryo Takahashi, and Yongwei Yao.

Logic  
**Thursday, April 07, 2022, 4:00pm-5:30pm**  
2866 East Hall  
Iian Smythe (UM)  
*Equivalence of generic reals (Part 2)*

We will continue to discuss the equivalence relation on generic reals added by forcing, this time focusing on random reals.
Special Events
Thursday, April 07, 2022, 5:30pm-6:30pm
3866 East Hall
Paul Kessenich (UM)

*Jobs in Academia for Mathematicians Workshop - Teaching statements*

Variational Analysis and Optimization
Thursday, April 07, 2022, 9:00am-10:00am
Virtual
Peter Wolenski (Louisiana State University)

*Optimal Control with piecewise constant dynamics*

Please see the abstract in the attached file.

Zoom Link:
https://umich.zoom.us/j/95524251106?pwd=TUN5SnIVQzB5bGRtejZRU2NhVXpJUT09

Meeting ID: 955 2425 1106
Passcode: 491904

Representation Stability
Friday, April 08, 2022, 1:00pm-2:00pm
Online
Nir Gadish (University of Michigan)

*Is there representation stability in high dimensional cohomology of moduli spaces of curves?*

Moduli spaces of algebraic curves of fixed genus and n marked points satisfy representation stability as n grows, meaning in particular that every Betti number grows polynomially in n. However, the Euler characteristics grow superexponentially in n, so there must be LOTS of unstable cohomology. I’ll explain how tropical geometry gives access to part of the unstable cohomology, and relates it to configurations on graphs. With this, there is hope to recover a form of representation stability beyond the stable range. I will discuss the challenges and machinery that needs to be developed in order to interpret stability in genus > 2.
Student Algebraic Geometry  
Friday, April 08, 2022, 3:00pm-4:00pm  
2866 East Hall  
Saket Shah (UM)  
27 Lines on a Cubic Surface  

This will be an introductory talk, with the end goal of establishing the classical result that there exist 27 lines on a cubic surface. We will discuss a bit of intersection theory and the other preliminary notions: in particular, we will more precisely state what it means to be a "line" on a cubic surface.

Applied Interdisciplinary Mathematics (AIM)  
Friday, April 08, 2022, 3:00pm-4:00pm  
Virtual  
David Bindel (Cornell University)  
The Structure and Interpretation of Graph Spectral Densities  

In this talk, we report ongoing work on the analysis of graphs via global summaries of the eigenvalue distributions and eigenvector behavior. Our approach is drawn from the condensed matter physics literature, where the idea of local and global densities of states is often used to understand the electronic structure of systems, and we describe how these densities play a common role in such seemingly disparate topics as spectral geometry, condensed matter physics, and the study of centrality measures in graphs. We then discuss how structural motifs manifest in the spectrum, give fast algorithms to estimate spectral densities, and conclude with a discussion of some of our current research directions in applying these tools to the analysis of large-scale graphs.

Learning Seminar in Representation Stability  
Friday, April 08, 2022, 4:00pm-4:50pm  
1866 East Hall  
Karol Koziol (UM)  
Morita theory  

I'll give a leisurely introduction to several different flavors of Morita equivalence, which provides conditions for two categories to be equivalent. I'll start at the classical version and build up to a souped-up version for derived categories which shows up in some Langlands things I've been thinking about recently.
Chronic pain troubles over 40,000,000 Americans, reducing their quality of life and presenting a significant burden on the American medical system. When non-invasive treatments fail, many chronic pain patients turn to spinal cord stimulation (SCS). In SCS, a device which delivers small electric shocks is implanted in the patient's spinal cord. Fortunately, SCS helps about 50% of patients! Why, though, does SCS help some patients but not others? Why does SCS help at all? We seek to answer these questions by treating the network of neurons constituting the spinal cord as a system of microcircuits, wherein each microcircuit consists of several interacting populations of neurons. These microcircuits reflect the heterogeneity experimentally observed in the spinal cord, and may be divided into classes according to their network structures, neuron types, and expected behaviors. To understand how these microcircuits respond to increasing stimulation intensities, we model each microcircuit as a system of differential equations with noisy input corresponding to SCS stimulation intensity, wherein the model variables are the population averages of the membrane voltages of the neurons. Through such modeling, we find various means by which we can induce the microcircuits to transmit painful signals as they might for patients experiencing chronic pain. Moreover, we show that increasing SCS stimulation intensity from zero can reduce, increase, or non-monotonically affect painful signals according to microcircuit class and within-class variation in model parameters. This suggests that we can identify which sets of microcircuits collectively transmit less pain in response to increasing stimulation intensities, and hence for which SCS could alleviate chronic pain. In this talk, we illustrate such results, explain the model, and highlight some of the existing theory behind the mechanisms of SCS. No prior knowledge of neuroscience is assumed!

Preprint Algebraic Geometry
Friday, April 08, 2022, 4:00pm-5:30pm
4096 East Hall
Lena Ji (UM)
The Lipman-Zariski conjecture, part II