### Weekly Seminar & Events Bulletin
November 7th, 2021 - November 13th, 2021

**Monday, November 08, 2021**

<table>
<thead>
<tr>
<th>Time</th>
<th>Event</th>
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<tbody>
<tr>
<td>3:00pm-4:00pm</td>
<td>RTG Seminar on Number Theory -- Stephanie Chan (University of Michigan)</td>
<td>Integral points on elliptic curves -- 4088 East Hall</td>
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<tr>
<td>4:00pm-5:00pm</td>
<td>Complex Analysis, Dynamics and Geometry -- Caroline Davis (Indiana)</td>
<td>Dynamical Gaskets -- on Zoom Virtual</td>
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<tr>
<td>4:00pm-5:00pm</td>
<td>Student Combinatorics -- Karthik Ganapathy (UM)</td>
<td>Noetherianity of posets -- 3866 East Hall</td>
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**Tuesday, November 09, 2021**

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<tr>
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<tbody>
<tr>
<td>4:00pm-5:00pm</td>
<td>Colloquium Series -- Geordie Williamson (University of Sydney)</td>
<td>Number Theory RTG Lectures I: Parity sheaf methods in representation theory -- virtual</td>
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**Wednesday, November 10, 2021**

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<tr>
<td>2:30pm-4:00pm</td>
<td>Learning Seminar in Algebraic Combinatorics -- Thomas Lam (UM)</td>
<td>Khovanov-Rozansky link homology via Soergel bimodules -- 4088 East Hall</td>
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<tr>
<td>4:00pm-5:00pm</td>
<td>Algebraic Geometry -- Geordie Williamson ()</td>
<td>(reserved for special lecture series) -- 4096 East Hall</td>
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<tr>
<td>4:00pm-5:00pm</td>
<td>Financial/Actuarial Mathematics -- Chuhao Sun (UM)</td>
<td>Optimal ergodic harvesting under ambiguity -- 1324 East Hall</td>
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<tr>
<td>4:00pm-5:00pm</td>
<td>MCAIM Colloquium -- Jacob Bedrossian (University of Maryland)</td>
<td>Hydrodynamic stability at high Reynolds number -- B844 and on Zoom East Hall</td>
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<tr>
<td>4:00pm-5:00pm</td>
<td>Group, Lie and Number Theory -- Geordie Williamson (University of Sydney)</td>
<td>Number Theory RTG Lectures II -- virtual</td>
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**Thursday, November 11, 2021**

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<td>Topology -- Francis Bonahon (University of Southern California)</td>
<td>Quantum invariants of surface diffeomorphisms and 3-dimensional hyperbolic geometry -- 3866 East Hall</td>
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<tr>
<td>4:00pm-5:00pm</td>
<td>Group, Lie and Number Theory -- Geordie Williamson (University of Sydney)</td>
<td>Number Theory RTG Lectures III -- virtual</td>
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<tr>
<td>4:00pm-5:30pm</td>
<td>Logic -- Matthew Harrison-Trainor (UM)</td>
<td>Boosting the information density of binary strings -- 2866 East Hall</td>
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<tr>
<td>5:30pm-6:30pm</td>
<td>Student Dynamics/Geometry Topology -- Christopher Stith (University of Michigan)</td>
<td>Black hole spacetimes and closed trapped surfaces -- 3866 East Hall</td>
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**Friday, November 12, 2021**

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<tr>
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<td>Applied Interdisciplinary Mathematics (AIM) -- Jennifer Rieser (Emory University)</td>
<td>Phases, geometry, and scales: bridging micro to macro in animal locomotion -- ZOOM East Hall</td>
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<tr>
<td>3:00pm-4:00pm</td>
<td>Combinatorics -- Zachary Hamaker (University of Florida)</td>
<td>Symplectic Bumpless Pipe Dreams -- 4088 East Hall</td>
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<tr>
<td>3:00pm-4:00pm</td>
<td>Student Algebraic Geometry -- Gary Hu (UM)</td>
<td>Abelian Varieties -- 2866 East Hall</td>
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<tr>
<td>3:00pm-3:50pm</td>
<td>Learning Seminar in Representation Stability -- Kyu Jun (UM)</td>
<td>TBA -- 1866 East Hall</td>
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<tr>
<td>4:00pm-5:30pm</td>
<td>Arithmetic Geometry Learning -- Sebastian Olano (University of Michigan)</td>
<td>Introduction to perverse sheaves and the decomposition theorem -- 4096 East Hall</td>
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<tr>
<td>4:00pm-5:00pm</td>
<td>MCAIM Graduate Seminar -- Guanhua Sun (University of Michigan)</td>
<td>Why do we sleep: Three Synaptic Hypothesis -- 2866 East Hall</td>
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Abstracts for the week of November 7th, 2021 - November 13th, 2021

**RTG Seminar on Number Theory**  
**Monday, November 08, 2021, 3:00pm-4:00pm**  
4088 East Hall  
**Stephanie Chan (University of Michigan)**  
*Integral points on elliptic curves*

Given an elliptic curve over a number field with an integral model, we can study the integral points on the curve. Taking an infinite family of elliptic curves and imposing some ordering, we may ask how often a curve has an integral point and how many integral points there are on average. I will discuss some results related to the distribution of integral points in elliptic curve families.

**Complex Analysis, Dynamics and Geometry**  
**Monday, November 08, 2021, 4:00pm-5:00pm**  
on Zoom Virtual  
**Caroline Davis (Indiana)**  
*Dynamical Gaskets*

We present a dynamical interpretation of the speakers favorite topological fact: that the Apollonian gasket is a 4:1 cover of the Sierpinski triangles. Then, we discuss this result in terms of groups and games.

This talk will be given on Zoom. For the Zoom info, please email Sarah (kochsc@umich.edu).

**Student Combinatorics**  
**Monday, November 08, 2021, 4:00pm-5:00pm**  
3866 East Hall  
**Karthik Ganapathy (UM)**  
*Noetherianity of posets*

We will define the notion of noetherianity for a partially ordered set. After seeing various characterizations of noetherianity, we will connect this to the noetherianity of rings. Finally, we will prove Higman's Lemma, which is a powerful tool to produce new noetherian posets out of existing ones. Higman's Lemma is extensively used in computer science, but has recently been used to prove the noetherianity of many large algebraic structures.
Wigner spoke of the “the unreasonable effectiveness of mathematics in the natural sciences”. This lecture series will concern “the unreasonable effectiveness of sheaves in representation theory”. Nowadays, there exists dozens of examples where quantities of central importance in representation theory (dimensions, character values, Jordan-Hölder multiplicities, ...) are encoded in the stalks of interesting sheaves (intersection cohomology sheaves, ...). This establishes a fascinating connection between geometry and representation theory. In the first talk (which will be colloquium style) I will try to motivate intersection cohomology and the Decomposition Theorem via the problem of predicting the cohomology of a fibre of a map. I will then go on to introduce parity sheaves and geometric extensions (which are more recent generalizations of parity sheaves). Finally, I will explain how parity sheaves help understand several central questions in modular representation theory.

https://umich.zoom.us/j/94261794390?pwd=Z1NnNTgrVFJNSVVURkFiNkdoNXBLdz09

Meeting ID: 942 6179 4390
Passcode: UMNTRTG

Learning Seminar in Algebraic Combinatorics
Wednesday, November 10, 2021, 2:30pm-4:00pm
4088 East Hall
Thomas Lam (UM)
Khovanov-Rozansky link homology via Soergel bimodules

I will define Khovanov and Rozansky's triply graded link homology theory, using the modern approach of Soergel bimodules. This categorifies the construction of the HOMFLY polynomial via the Hecke algebra.

Algebraic Geometry
Wednesday, November 10, 2021, 4:00pm-5:00pm
4096 East Hall
Geordie Williamson ()
(reserved for special lecture series)
We consider an ergodic harvesting problem with model ambiguity that arises from biology. The problem is constructed as a stochastic game with two players: the decision-maker (DM) chooses the `best' harvesting policy and an adverse player chooses the `worst' probability measure. The main result is establishing an optimal control of the DM and showing that it is a threshold policy. The optimal threshold and the optimal payoff are obtained by solving a free-boundary problem emerging from the HJB equation. As part of the proof, we fix a gap that appeared in the HJB analysis of previous papers, which analyzed the risk-neutral version of the ergodic harvesting problem. Finally, we study the dependence of the optimal threshold and the optimal payoff on the ambiguity parameter and show that if the ambiguity goes to 0, the problem converges to the risk-neutral problem.

MCAIM Colloquium
Wednesday, November 10, 2021, 4:00pm-5:00pm
B844 and on Zoom East Hall
Jacob Bedrossian (University of Maryland)
Hydrodynamic stability at high Reynolds number

The stability of equilibria solutions of the incompressible Euler and Navier-Stokes equations at high Reynolds number has been studied since the 1800s with the work of Kelvin, Rayleigh, Reynolds and others. However, only in recent years have we started to get a firm mathematical understanding of this field, even for the deceptively simple case of shear flows and vortices. I will outline some of the many recent advances in the area, including inviscid damping, enhanced dissipation, subcritical transition, vortex axi-symmetrization, and the local well-posedness of vortex filaments.

Talk in person in East Hall B844

and on Zoom:

Join Zoom Meeting
https://umich.zoom.us/j/95889337803
Meeting ID:  958 8933 7803
Passcode: 811977
Group, Lie and Number Theory  
**Wednesday, November 10, 2021, 4:00pm-5:00pm**  
**virtual**  
**Geordie Williamson (University of Sydney)**  
*Number Theory RTG Lectures II*  

https://umich.zoom.us/j/94261794390?pwd=Z1NnNTgrVFJNSVVURkFiNkdoNXBLdz09

Meeting ID: 942 6179 4390  
Passcode: UMNTRTG

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**Topology**  
**Thursday, November 11, 2021, 4:00pm-5:00pm**  
**3866 East Hall**  
**Francis Bonahon (University of Southern California)**  
*Quantum invariants of surface diffeomorphisms and 3-dimensional hyperbolic geometry*

This talk is motivated by surprising connections between two very different approaches to 3-dimensional topology, namely quantum topology and hyperbolic geometry. The Kashaev-Murakami-Murakami Volume Conjecture connects the growth of colored Jones polynomials of a knot to the hyperbolic volume of its complement. More precisely, for each integer $n$, one evaluates the $n$-th Jones polynomial of the knot at the $n$-root of unity $\exp(2 \pi i/n)$. The Volume Conjecture predicts that this sequence grows exponentially as $n$ tends to infinity, with exponential growth rate related to the hyperbolic volume of the knot complement.

I will discuss a closely related conjecture for diffeomorphisms of surfaces, based on the representation theory of the Kauffman bracket skein algebra of the surface, a quantum topology object closely related to the Jones polynomial of a knot. I will describe the mathematics underlying this conjecture, which involves a certain Frobenius principle in quantum algebra. I will also present experimental evidence for the conjecture, and describe partial results obtained in work in progress with Helen Wong and Tian Yang.

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**Group, Lie and Number Theory**  
**Thursday, November 11, 2021, 4:00pm-5:00pm**  
**virtual**  
**Geordie Williamson (University of Sydney)**  
*Number Theory RTG Lectures III*  

https://umich.zoom.us/j/94261794390?pwd=Z1NnNTgrVFJNSVVURkFiNkdoNXBLdz09

Meeting ID: 942 6179 4390  
Passcode: UMNTRTG
Given a binary string $s$, we can measure the information content of $s$ using Kolmogorov complexity. The information density of $s$ is the Kolmogorov complexity of $s$ divided by the length of $s$. We will consider the problem of producing, from a string $s$, a shorter string $s'$ of higher information density than $s$ ("extracting" the complexity from $s$). In fact we cannot do this, but we can produce two shorter strings $s'$ and $s''$ such that one of the two will have higher information density than $s$. I will talk about this problem, which turns out to be equivalent to a purely graph-theoretic problem about how spread out the edges in a graph can be.

Black holes are a celebrated prediction of general relativity. We will discuss them from a geometric point of view, first centering our discussion on the Schwarzschild metric. Throughout the talk, we draw from physical intuition so as to arrive at interesting and bizarre physical interpretations; however, no prior knowledge of general relativity will be assumed. Time permitting, we will discuss various related topics such as closed trapped surfaces and their formation, Penrose's incompleteness theorem and/or cosmic censorship.
Applied Interdisciplinary Mathematics (AIM)
Friday, November 12, 2021, 3:00pm-4:00pm
ZOOM East Hall
Jennifer Rieser (Emory University)
Phases, geometry, and scales: bridging micro to macro in animal locomotion

Animals move through the terrestrial world in a variety of ways – burrowing, crawling, running, jumping, climbing, and building. Successful movements, often crucial for survival, depend sensitively on the details of how animals manipulate their surroundings. The proper coordination of body and limbs, as well as managing frictional interactions between body parts and substrates, are both essential components for successful movement. In the first part of this talk, I will present a geometric framework for movement, originally proposed by Wilczek and Shapere nearly 40 years ago, to describe self-deformation-driven movements through highly dissipative environments. Using granular resistive force theory to model environmental forces and principal components analysis to identify a low-dimensional space of animal postures and dynamics, I will show that our approach captures key features of how a variety of animals, from undulatory swimmers and slitherers to sidewinding rattlesnakes, coordinate body movements and leverage environmental interactions to generate locomotion. In the second part of this talk, I will discuss recent results highlighting how these modeling tools provide insights linking the evolution of snake scale microtextures to frictional interactions and behavioral adaptations that benefit locomotion.

Combinatorics
Friday, November 12, 2021, 3:00pm-4:00pm
4088 East Hall
Zachary Hamaker (University of Florida)
Symplectic Bumpless Pipe Dreams

Bumpless pipe dreams are combinatorial objects whose weighted sums give Schubert polynomials and Grothendieck polynomials. Since their introduction by Lam, Lee and Shimozono, they have been studied intensely, as it is unusual for such natural objects to appear out of thin cloth. In this talk, we introduce symplectic bumpless pipe dreams, whose weighted sums give symplectic Schubert and Grothendieck polynomials. These polynomials, indexed by fixed point free involutions, represent the classes of symplectic group orbits in the flag variety, or alternatively for skew-symmetric matrix Schubert varieties. We use these objects to prove a conjecture of Hamaker, Marberg and Pawlowski on principle specializations of these polynomials and discuss their relation to diagonal degenerations of skew-symmetric matrix Schubert varieties.
Abelian varieties are projective varieties which are also algebraic groups. They form an interesting class of geometric objects which can be used to study other varieties that arise in algebraic geometry and in number theory. In this talk, we will explore some basic properties and examples of abelian varieties, paying special attention to the Jacobian variety of a smooth projective curve.

**Learning Seminar in Representation Stability**  
Friday, November 12, 2021, 3:00pm-3:50pm  
1866 East Hall  
Kyu Jun (UM)  
*TBA*

**Arithmetic Geometry Learning**  
Friday, November 12, 2021, 4:00pm-5:30pm  
4096 East Hall  
Sebastian Olano (University of Michigan)  
*Introduction to perverse sheaves and the decomposition theorem*

**MCAIM Graduate Seminar**  
Friday, November 12, 2021, 4:00pm-5:00pm  
2866 East Hall  
Guanhua Sun (University of Michigan)  
*Why do we sleep: Three Synaptic Hypothesis*

Why do we sleep? What happens in our brain during sleep? How does synaptic activity affect our sleep and vice-versa? Scientists have been keen to answer these questions.

In this talk, I will survey through three synaptic hypotheses of sleep: 1. Synaptic Homeostasis Hypothesis(SHY) 2. Network Homeostasis Hypothesis 3. Phosphorylation Hypothesis. And I will present current computational works of a calcium plasticity model that can potentially test one or more of those three hypotheses.