**Weekly Seminar & Events Bulletin**  
**October 31st, 2021 - November 6th, 2021**

### Monday, November 01, 2021

<table>
<thead>
<tr>
<th>Time</th>
<th>Event</th>
<th>Speaker</th>
<th>Location</th>
</tr>
</thead>
<tbody>
<tr>
<td>3:00pm-4:00pm</td>
<td><strong>RTG Seminar on Number Theory</strong> -- Nate Harman (University of Michigan)</td>
<td><em>Admissible Representations of Infinite-Rank Arithmetic Groups</em></td>
<td>4088 East Hall</td>
</tr>
<tr>
<td>4:00pm-5:00pm</td>
<td><strong>Complex Analysis, Dynamics and Geometry</strong> -- Ethan Farber (Boston College)</td>
<td><em>A Farey tree structure on a family of pseudo-Anosov braids</em></td>
<td>3096 East Hall</td>
</tr>
<tr>
<td>4:00pm-5:15pm</td>
<td><strong>RTG Representation Theory</strong> -- Linh Truong (UM)</td>
<td><em>Quantum sl2 and knots</em></td>
<td>4088 East Hall</td>
</tr>
<tr>
<td>4:00pm-5:00pm</td>
<td><strong>Integrable Systems and Random Matrix Theory</strong> -- Maxim Derevyagin (University of Connecticut)</td>
<td><em>Discrete Darboux Transformations And Orthogonal Polynomials</em></td>
<td>ZOOM ID: 926 6491 9790 Virtual</td>
</tr>
<tr>
<td>4:00pm-5:00pm</td>
<td><strong>Student Combinatorics</strong> -- Teresa Yu (UM)</td>
<td><em>Introduction to Gröbner Bases</em></td>
<td>3866 East Hall</td>
</tr>
</tbody>
</table>

### Tuesday, November 02, 2021

<table>
<thead>
<tr>
<th>Time</th>
<th>Event</th>
<th>Speaker</th>
<th>Location</th>
</tr>
</thead>
<tbody>
<tr>
<td>3:00pm-4:00pm</td>
<td><strong>Student Commutative Algebra</strong> -- Alapan Mukhopadhyay (University of Michigan, Ann Arbor)</td>
<td><em>Singularities in Positive Characteristic</em></td>
<td>2866 East Hall</td>
</tr>
<tr>
<td>4:00pm-5:00pm</td>
<td><strong>Colloquium Series</strong> -- Han Huang (Georgia Tech)</td>
<td><em>Sumner Myers Award Lecture</em></td>
<td>1360 East Hall</td>
</tr>
</tbody>
</table>

### Wednesday, November 03, 2021

<table>
<thead>
<tr>
<th>Time</th>
<th>Event</th>
<th>Speaker</th>
<th>Location</th>
</tr>
</thead>
<tbody>
<tr>
<td>2:30pm-4:00pm</td>
<td><strong>Learning Seminar in Algebraic Combinatorics</strong> -- George Seelinger (UM)</td>
<td><em>The Shuffle Theorem</em></td>
<td>4088 East Hall</td>
</tr>
<tr>
<td>4:00pm-5:30pm</td>
<td><strong>Algebraic Geometry</strong> -- Mirko Mauri (University of Michigan)</td>
<td><em>Supports and singularities of the Hitchin fibration</em></td>
<td>4096 East Hall</td>
</tr>
<tr>
<td>4:00pm-5:00pm</td>
<td><strong>MCAIM Colloquium</strong> -- Christopher Rycroft (Harvard University)</td>
<td><em>Uncovering the Rules of Crumpling with a Data-Driven Approach</em></td>
<td>B844 East Hall</td>
</tr>
</tbody>
</table>

### Thursday, November 04, 2021

<table>
<thead>
<tr>
<th>Time</th>
<th>Event</th>
<th>Speaker</th>
<th>Location</th>
</tr>
</thead>
<tbody>
<tr>
<td>3:00pm-4:00pm</td>
<td><strong>Topology</strong> -- Asaf Katz (University of Michigan)</td>
<td><em>Equidistribution of large spheres in horospheres</em></td>
<td>3866 East Hall</td>
</tr>
<tr>
<td>4:00pm-5:30pm</td>
<td><strong>Arithmetic Geometry Learning</strong> -- James Hotchkiss (University of Michigan)</td>
<td><em>The motivic nature of the Leray filtration, after Arapura</em></td>
<td>4096 East Hall</td>
</tr>
<tr>
<td>4:00pm-5:30pm</td>
<td><strong>Logic</strong> -- Andreas Blass (UM)</td>
<td><em>Tukey ordering and forcing preservation of ultrafilters</em></td>
<td>2866 East Hall</td>
</tr>
<tr>
<td>5:30pm-6:30pm</td>
<td><strong>Student Dynamics/Geometry Topology</strong> -- Bradley Zykoski (University of Michigan)</td>
<td><em>Fundamental Groups and Flat Connections</em></td>
<td>3866 East Hall</td>
</tr>
</tbody>
</table>

### Friday, November 05, 2021

<table>
<thead>
<tr>
<th>Time</th>
<th>Event</th>
<th>Speaker</th>
<th>Location</th>
</tr>
</thead>
<tbody>
<tr>
<td>3:00pm-4:00pm</td>
<td><strong>Applied Interdisciplinary Mathematics (AIM)</strong> -- Jason Kaye (Flatiron Institute)</td>
<td><em>Efficient numerical algorithms for simulating quantum dynamics</em></td>
<td>ZOOM East Hall</td>
</tr>
<tr>
<td>3:00pm-4:00pm</td>
<td><strong>Student Algebraic Geometry</strong> -- Andy Gordon (UM)</td>
<td><em>An Introduction to Intersection Theory</em></td>
<td>2866 East Hall</td>
</tr>
<tr>
<td>3:00pm-4:00pm</td>
<td><strong>Combinatorics</strong> -- Claudia Yun (Brown University)</td>
<td><em>Homology representations of compactified configurations on graphs</em></td>
<td>4088 East Hall</td>
</tr>
<tr>
<td>3:00pm-3:50pm</td>
<td><strong>Learning Seminar in Representation Stability</strong> -- Jenny Wilson (UM)</td>
<td><em>TBA</em></td>
<td>1866 East Hall</td>
</tr>
<tr>
<td>4:00pm-5:30pm</td>
<td><strong>Geometry</strong> -- Paul Apisa (U Michigan)</td>
<td><em>Billiards in Right Triangles and Dynamics on Moduli Space!</em></td>
<td>3866 East Hall</td>
</tr>
<tr>
<td>4:00pm-5:30pm</td>
<td><strong>Preprint Algebraic Geometry</strong> -- Swaraj Pande ()</td>
<td><em>Saturation bounds for smooth varieties</em></td>
<td>4096 East Hall</td>
</tr>
</tbody>
</table>
4:00pm-5:00pm  **Student AIM Seminar** -- Scott Weady (New York University) *Anomalous natural convective sculpting of melting ice* -- Virtual
Abstracts for the week of October 31st, 2021 - November 6th, 2021

RTG Seminar on Number Theory
Monday, November 01, 2021, 3:00pm-4:00pm
4088 East Hall
Nate Harman (University of Michigan)
Admissible Representations of Infinite-Rank Arithmetic Groups

A theorem of Bass-Milnor-Serre says that for \( n > 2 \) every finite dimensional representation of \( \text{SL}_n(\mathbb{Z}) \) virtually extends to a representation of \( \text{SL}_n(\mathbb{R}) \) -- meaning there is a representation of \( \text{SL}_n(\mathbb{R}) \) that agrees with it along a finite index subgroup of \( \text{SL}_n(\mathbb{Z}) \). Moreover this theorem is fairly tight in the sense that if we remove any of the phrases "\( n > 2 \)", "finite dimensional", or "virtually" then this theorem fails spectacularly. \( \text{SL}_{\infty}(\mathbb{Z}) \) has no non-trivial finite dimensional representations and no finite index subgroups, but nevertheless I will formulate an infinite-rank version of this theorem.

Complex Analysis, Dynamics and Geometry
Monday, November 01, 2021, 4:00pm-5:00pm
3096 East Hall
Ethan Farber (Boston College)
A Farey tree structure on a family of pseudo-Anosov braids

Under the right conditions, an expanding interval map can be realized as the train track map of a pseudo-Anosov braid. In particular, the family of such maps with two critical values is parameterized by the rationals in the open interval \((0,1)\). We investigate this parameterization, showing that it in fact carries the structure of the Farey tree. In this talk, I will describe some of the fruit born of this structure. For example, the rational parameter grows monotonically in the dilatation of the braid, and these dilatations are “eventually” Salem numbers, in a suitable sense. Given the time, we will also investigate the structure of the set of Galois conjugates of these dilatations.

This talk will be on Zoom. Please email Sarah at kochsc@umich.edu for the Zoom info!

RTG Representation Theory
Monday, November 01, 2021, 4:00pm-5:15pm
4088 East Hall
Linh Truong (UM)
Quantum sl2 and knots
Integrable Systems and Random Matrix Theory  
**Monday, November 01, 2021, 4:00pm-5:00pm**  
**ZOOM ID: 926 6491 9790 Virtual**  
**Maxim Derevyagin (University of Connecticut)**  
*Discrete Darboux Transformations And Orthogonal Polynomials*

Two basic discrete Darboux transformations in the theory of orthogonal polynomials are called Geronimus and Christoffel transformations. The consistency relation for those two gives the discrete Toda equation, a discrete integrable system, and it can also be considered as a relation between the elements of the Padé table.

In this talk, we are going to review the basics of discrete Darboux transformations for orthogonal polynomials. Then we’ll show how such transformations can lead to Sobolev orthogonal polynomials, exceptional orthogonal polynomials, and indefinite orthogonal polynomials. Some associated asymptotic results for orthogonal polynomials and convergence results for underlying Padé approximants will be presented as well.

*A recording of the talk can be found [here](https://youtu.be/5zB90EkchUE).*

Student Combinatorics  
**Monday, November 01, 2021, 4:00pm-5:00pm**  
**3866 East Hall**  
**Teresa Yu (UM)**  
*Introduction to Gröbner Bases*

If \( R = k[x] \) with \( k \) a field, then determining whether or not a polynomial is in a particular ideal of \( R \) can be done with (polynomial) long division. However, what happens when \( R \) is a polynomial ring in multiple variables? In this talk, we’ll introduce Gröbner bases and discuss how they can be used to solve this problem. Along the way, we’ll discuss monomial orders, a division algorithm for polynomials in multiple variables, and Buchberger’s algorithm.

Student Commutative Algebra  
**Tuesday, November 02, 2021, 3:00pm-4:00pm**  
**2866 East Hall**  
**Alapan Mukhopadhyay (University of Michigan, Ann Arbor)**  
*Singularities in Positive Characteristic*

We will introduce notions of singularities of a hypersurface at a point from analytic and algebro-geometric points of view in characteristic zero. Then we will relate these notions to seemingly different measures of ‘singularities’ coming up in positive characteristic commutative algebra.
Colloquium Series
Tuesday, November 02, 2021, 4:00pm-5:00pm
1360 East Hall
Han Huang (Georgia Tech)
Sumner Myers Award Lecture

When can we recover an Erdos-Renyi graph from its local structure?

Suppose we have a graph G. For each vertex v of G, we observed the local structure of the G at this vertex v. Precisely, we have the induced subgraph containing all vertices at a distance at most 1 to v (including v), but the labels of the neighbors of v have been removed. Now, can we reconstruct graph G based on these local structures at each vertex? This question was proposed by Mossel and Ross, which was motivated by DNA shotgun assembly.

To reconstruct the graph, the local structures need to have sufficient complexity. Previously, Gaudio and Mossel show that for the Erdos Renyi graph G(n,p), one cannot reconstruct the graph from its local structures when \( p = o(n^{-1/2}) \). For such values of p, unique reconstruction is not possible because the number of typical realizations of Erdos Renyi Graphs is much more than the number of typical realizations of the overall local structures. Recently, with Tikhomirov, we managed to confirm that the transition for the unique reconstruction of G(n,p) graphs happens at the level when p is at \( n^{-1/2} \) up to a polylog n factor.

Learning Seminar in Algebraic Combinatorics
Wednesday, November 03, 2021, 2:30pm-4:00pm
4088 East Hall
George Seelinger (UM)
The Shuffle Theorem

We will give a proof of the shuffle theorem by realizing \( \nabla e_n \) as a raising operator series via connections to the elliptic Hall algebra of Burban and Schiffmann and the shuffle algebra. Then, we will expand this raising operator series into a sum of the series LLT polynomials of Grojnowski and Haiman. The shuffle theorem will then be a corollary by taking the polynomial truncation of this identity of series.
The decomposition theorem for proper morphisms grants that the cohomology of the domain splits in elementary summands. However, in general, it is a subtle task to determine explicitly these summands. We prove that this is in fact possible in the case of Hitchin fibrations for Higgs bundles of arbitrary degree. Surprisingly we relate the summands of the decomposition theorem to the singularity theory of the moduli spaces of Higgs bundles in (fixed!) degree zero. We also provide a combinatorial version of the decomposition theorem via counts of lattice points in zonotopes. This is based on a work in progress with Luca Migliorini and Roberto Pagaria.
Weekly Seminar & Events Bulletin
October 31st, 2021 - November 6th, 2021

MCAIM Colloquium
Wednesday, November 03, 2021, 4:00pm-5:00pm
B844 East Hall
Christopher Rycroft (Harvard University)
Uncovering the Rules of Crumpling with a Data-Driven Approach

When a sheet of paper is crumpled, it spontaneously develops a network of creases. Despite the apparent disorder of this process, statistical properties of crumpled sheets exhibit striking reproducibility. Recent experiments have shown that when a sheet is repeatedly crumpled, the total crease length grows logarithmically [1]. This talk will offer insight into this surprising result by developing a correspondence between crumpling and fragmentation processes. We show how crumpling can be viewed as fragmenting the sheet into flat facets that are outlined by the creases, and we use this model to reproduce the characteristic logarithmic scaling of total crease length, thereby supplying a missing physical basis for the observed phenomenon [2].

This study was made possible by large-scale data analysis of crease networks from crumpling experiments. We will describe recent work to use the same data with machine learning methods to probe the physical rules governing crumpling. We will look at how augmenting experimental data with synthetically generated data can improve predictive power and provide physical insight [3].


Join us in person or on Zoom:
https://umich.zoom.us/j/95889337803
Meeting ID: 958 8933 7803 Passcode: 811977

Link to the video of this lecture:
http://leccap.engin.umich.edu/leccap/site/rgdjr1he1k719zc6x17
A profound result of modern harmonic analysis is Stein's spherical differentiation theorem. To the surprise of many, one may prove a spherical ergodic theorem for $\mathbb{R}^n$ actions as a corollary to this result.

Based on intuition coming from equidistribution problems in the Euclidean space and the spherical ergodic theorem, Lindenstrauss and Margulis conjectured an effective spherical equidistribution theorem for horospherical actions.

In the talk, I will present a proof of their conjecture, drawing on techniques from the theory of oscillatory integrals from harmonic analysis on one hand and Venkatesh's effective disjointness theorem from homogeneous dynamics on the other.

If time permits, I will mention some other approaches, mostly due to myself, towards this problem, including results regarding singular Bochner-Riesz means and the analogous question for $\mathbb{R}^n$ nilflows.
Student Dynamics/Geometry Topology  
**Thursday, November 04, 2021, 5:30pm-6:30pm**  
3866 East Hall  
**Bradley Zykoski (University of Michigan)**  
*Fundamental Groups and Flat Connections*  

In this talk, we will explore the geometric structures that can be encoded via representations of fundamental groups, and the equivalence between such structures and flat connections on a suitable bundle.

Applied Interdisciplinary Mathematics (AIM)  
**Friday, November 05, 2021, 3:00pm-4:00pm**  
ZOOM East Hall  
**Jason Kaye (Flatiron Institute)**  
*Efficient numerical algorithms for simulating quantum dynamics*  

I will describe a few algorithmic advances which reduce computational bottlenecks in simulations of quantum many-body dynamics. In time-dependent density functional theory (TDDFT), the many-body wavefunction is approximated using a collection of single-particle wavefunctions, which independently satisfy the Schrödinger equation and are coupled through an effective potential. I will introduce a high-order, FFT-based solver for free space (nonperiodic) problems in TDDFT which sidesteps the usual requirement of imposing artificial boundary conditions. Many-body Green's functions, which describe correlations between quantum observables, enable practical simulations beyond the effective one-body picture of TDDFT. The Green's functions satisfy history dependent Volterra integro-differential equations with kernel nonlinearities. I will outline efficient history integration algorithms which significantly extend feasible propagation times in both equilibrium and nonequilibrium calculations.

Student Algebraic Geometry  
**Friday, November 05, 2021, 3:00pm-4:00pm**  
2866 East Hall  
**Andy Gordon (UM)**  
*An Introduction to Intersection Theory*  

This talk will give an overview of the core concepts of intersection theory. The subject will be introduced via an extended example of how (co)homological computations can be used to solve enumerative problems. Some (singular) homology would be useful as a prerequisite, but isn't necessary.
Combinatorics  
Friday, November 05, 2021, 3:00pm-4:00pm  
4088 East Hall  
Claudia Yun (Brown University)  
*Homology representations of compactified configurations on graphs*

The $n$-th ordered configuration space of a graph parametrizes ways of placing $n$ distinct and labelled particles on that graph. The homology of the one-point compactification of such configuration space is equipped with commuting actions of a symmetric group and the outer automorphism group of a free group. We give a cellular decomposition of these configuration spaces on which the actions are realized cellularly and thus construct an efficient free resolution for their homology representations. As our main application, we obtain computer calculations of the top weight rational cohomology of the moduli spaces $M_{2,n}$, equivalently the rational homology of the tropical moduli spaces $\Delta_{2,n}$, as a representation of $S_n$ acting by permuting point labels for all $n \leq 10$. This is joint work with Christin Bibby, Melody Chan, and Nir Gadish. Our paper can be found on arXiv with ID 2109.03302.

Learning Seminar in Representation Stability  
Friday, November 05, 2021, 3:00pm-3:50pm  
1866 East Hall  
Jenny Wilson (UM)  
*TBA*

Geometry  
Friday, November 05, 2021, 4:00pm-5:30pm  
3866 East Hall  
Paul Apisa (U Michigan)  
*Billiards in Right Triangles and Dynamics on Moduli Space!*

On a rational right triangle, i.e. one whose angles are all rational multiples of pi, how many (bands of) periodic billiard trajectories of length at most $L$ are there? Amazingly, this question is related to dynamics on the moduli space of Riemann surfaces. Each rational polygon $P$ may be unfolded to a closed surface tiled by copies of $P$. I will begin by describing how $GL(2,\mathbb{R})$ acts on the collection of such flat surfaces and how the $GL(2,\mathbb{R})$ orbit closure of the unfolding of $P$ controls many dynamical properties of billiard flow on $P$. I will then explain how to compute the orbit closure of the unfolding of every rational right triangle and describe the consequences it has for billiards.

Key ingredients in the proof include variational formulas in Teichmuller theory, the work of Eskin and Mirzakhani on orbit closures, and the work of Eskin, Kontsevich, and Zorich on sums of Lyapunov exponents.
Preprint Algebraic Geometry
Friday, November 05, 2021, 4:00pm-5:30pm
4096 East Hall
Swaraj Pande ()
Saturation bounds for smooth varieties
https://arxiv.org/abs/2104.01218 by Ein, Ha, and Lazarsfeld

Student AIM Seminar
Friday, November 05, 2021, 4:00pm-5:00pm
Virtual
Scott Weady (New York University)
Anomalous natural convective sculpting of melting ice

We study the shape dynamics of ice melting in cold, initially quiescent fresh water, subject to the natural convective flows generated during melting. Experiments reveal three shape motifs associated with increasing far-field water temperature: sharp pinnacles pointed downward, scalloped waves, and sharp pinnacles pointed upward. Phase-field simulations reproduce these morphologies, which are closely tied to the anomalous density-temperature profile of liquid water. Analysis shows pinnacles sharpen with accelerating growth of tip curvature, while scallops emerge from a Kelvin-Helmholtz-like instability caused by counter currents that roll up to form arrays of wall-bound vortices.