## 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>
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<tbody>
<tr>
<td>3:00pm-4:00pm</td>
<td><strong>RTG Seminar on Number Theory</strong> -- Nate Harman (University of Michigan) <strong>Admissible Representations of Infinite-Rank Arithmetic Groups</strong></td>
<td>4088 East Hall</td>
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<tr>
<td>4:00pm-5:00pm</td>
<td><strong>Complex Analysis, Dynamics and Geometry</strong> -- Ethan Farber (Boston College) <strong>A Farey tree structure on a family of pseudo-Anosov braids</strong></td>
<td>3096 East Hall</td>
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<td>4:00pm-5:15pm</td>
<td><strong>RTG Representation Theory</strong> -- Linh Truong (UM) <strong>Quantum sl2 and knots</strong></td>
<td>4088 East Hall</td>
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<td>4:00pm-5:00pm</td>
<td><strong>Integrable Systems and Random Matrix Theory</strong> -- Maxim Derevyagin (University of Connecticut) <strong>Discrete Darboux Transformations And Orthogonal Polynomials</strong></td>
<td>Virtual ZOOM ID: 926 6491 9790 Virtual</td>
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<td>4:00pm-5:00pm</td>
<td><strong>Student Combinatorics</strong> -- Teresa Yu (UM) <strong>Introduction to Gr&quot;{o}bner Bases</strong></td>
<td>3866 East Hall</td>
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### Tuesday, November 02, 2021

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<td>3:00pm-4:00pm</td>
<td><strong>Student Commutative Algebra</strong> -- Alapan Mukhopadhyay (University of Michigan, Ann Arbor) <strong>Singularities in Positive Characteristic</strong></td>
<td>2866 East Hall</td>
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<tr>
<td>4:00pm-5:00pm</td>
<td><strong>Colloquium Series</strong> -- Han Huang (Georgia Tech) <strong>Sumner Myers Award Lecture</strong></td>
<td>1360 East Hall</td>
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### Wednesday, November 03, 2021

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<tr>
<td>4:00pm-5:30pm</td>
<td><strong>Algebraic Geometry</strong> -- Mirko Mauri (University of Michigan) <strong>Supports and singularities of the Hitchin fibration</strong></td>
<td>4096 East Hall</td>
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<tr>
<td>4:00pm-5:00pm</td>
<td><strong>MCAIM Colloquium</strong> -- Christopher Rycroft (Harvard University) <strong>Uncovering the Rules of Crumpling with a Data-Driven Approach</strong></td>
<td>B844 East Hall</td>
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### Thursday, November 04, 2021

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<td>4:00pm-5:30pm</td>
<td><strong>Arithmetic Geometry Learning</strong> -- James Hotchkiss (University of Michigan) <strong>The motivic nature of the Leray filtration, after Arapura</strong></td>
<td>4096 East Hall</td>
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### Friday, November 05, 2021

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<td>12:00am-12:00am</td>
<td><strong>Geometry</strong> -- Paul Apisa (U Michigan) <strong>TBA</strong></td>
<td>3866 East Hall</td>
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<td>3:00pm-4:00pm</td>
<td><strong>Applied Interdisciplinary Mathematics (AIM)</strong> -- Jason Kaye (Flatiron Institute) <strong>Efficient numerical algorithms for simulating quantum dynamics</strong></td>
<td>ZOOM East Hall</td>
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<td>3:00pm-4:00pm</td>
<td><strong>Student Algebraic Geometry</strong> -- Andy Gordon (UM) <strong>TBA</strong></td>
<td>2866 East Hall</td>
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<td>3:00pm-4:00pm</td>
<td><strong>Combinatorics</strong> -- Claudia Yun (Brown University) <strong>Homology representations of compactified configurations on graphs</strong></td>
<td>4088 East Hall</td>
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<td>3:00pm-3:50pm</td>
<td><strong>Learning Seminar in Representation Stability</strong> -- Jenny Wilson (UM) <strong>TBA</strong></td>
<td>1866 East Hall</td>
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<td>4:00pm-5:30pm</td>
<td><strong>Preprint Algebraic Geometry</strong> -- Swaraj Pande (U Michigan) <strong>Saturation bounds for smooth varieties</strong></td>
<td>4096 East Hall</td>
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<td>4:00pm-5:00pm</td>
<td><strong>Student AIM Seminar</strong> -- Scott Weady (New York University) <strong>Anomalous natural convective sculpting of melting ice</strong></td>
<td>Virtual</td>
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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 \text{sl}2 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 will 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.

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 $\mathcal{A}_c, \mathcal{E}_c, \mathcal{S}_c, \mathcal{H}_c$ coming up in positive characteristic commutative algebra.
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.

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
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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:
hits://umich.zoom.us/j/95889337803
Meeting ID: 958 8933 7803 Passcode: 811977

Arithmetic Geometry Learning
Thursday, November 04, 2021, 4:00pm-5:30pm
4096 East Hall
James Hotchkiss (University of Michigan)
The motivic nature of the Leray filtration, after Arapura

Geometry
Friday, November 05, 2021, 12:00am-12:00am
3866 East Hall
Paul Apisa (U Michigan)
TBA
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.
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

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.