## Weekly Seminar & Events Bulletin

### January 30th, 2022 - February 5th, 2022

**Monday, January 31, 2022**

<table>
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<th>Time</th>
<th>Event</th>
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| 9:00am-10:00am | **Integrable Systems and Random Matrix Theory** -- Giulio Ruzza (Université Catholique de Louvain)  
*Airy process and Korteweg-de Vries equation* -- ZOOM ID: 926 6491 9790 Virtual | Virtual                   |                                                                                 |
| 3:00pm-4:00pm | **RTG Seminar on Number Theory** -- Tasho Kaletha (University of Michigan)  
*TBA* -- 4088 East Hall | 4088 East Hall             |                                                                                 |
| 3:00pm-5:15pm | **RTG Representation Theory** -- Tasho Kaletha (UM)  
*Trace formula for SL2 and its stabilization* -- ZOOM ID: 926 6491 9790 Virtual | Virtual                   |                                                                                 |
| 4:00pm-5:00pm | **Complex Analysis, Dynamics and Geometry** -- Giulio Tiozzo (University of Toronto)  
*A global shadow lemma and logarithm law in Hilbert geometry* -- https://umich.zoom.us/j/97288641488 Virtual | Virtual                   |                                                                                 |
| 4:00pm-5:00pm | **Student Combinatorics** -- Jin Baek (UM)  
*On the Erdos-Tuza-Valtr Conjecture* -- 3866 East Hall | 3866 East Hall             |                                                                                 |
| 4:00pm-5:00pm | **Donaldson-Thomas Theory** -- James Hotchkiss ()  
*The intrinsic normal cone* -- 4096 East Hall | 4096 East Hall             |                                                                                 |
| 5:00pm-6:00pm | **Student Dynamics/Geometry Topology** -- ()  
*Lightning Talks! (Part 1)* -- 3866 East Hall | 3866 East Hall             |                                                                                 |

**Tuesday, February 01, 2022**

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| 3:00pm-4:00pm | **Student Commutative Algebra** -- Teresa Yu (University of Michigan, Ann Arbor)  
*Resolutions over hypersurface rings* -- 3088 East Hall | 3088 East Hall             |                                                                                 |
| 4:00pm-5:00pm | **Colloquium Series** -- Sebastian Hurtado-Salazar (University of Chicago)  
*Volume vs Homotopy type for locally symmetric spaces* -- 4096 East Hall | 4096 East Hall             |                                                                                 |

**Wednesday, February 02, 2022**

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| 2:30am-4:00pm | **Learning Seminar in Algebraic Combinatorics** -- Thomas Lam (University of Michigan)  
*Cluster cohomology and knot homology* -- 4096 East Hall | 4096 East Hall             |                                                                                 |
| 4:00pm-5:00pm | **Financial/Actuarial Mathematics** -- Soren Christensen (Christian-Albrechts-University Kiel)  
*Learning to reflect - Data-driven solutions to singular control problems* -- Zoom Virtual | Zoom Virtual              |                                                                                 |
| 4:00pm-5:20pm | **Algebraic Geometry** -- Jakub Witaszek (UM)  
*Relative semiampleness in mixed characteristic* -- 4096 East Hall | 4096 East Hall             |                                                                                 |
| 4:00pm-5:30pm | **RTG Seminar on Geometry, Dynamics and Topology** -- Sebastian Hurtado (U Chicago)  
*Height gaps for groups of matrices and almost laws* -- 3866 East Hall | 3866 East Hall             |                                                                                 |

**Thursday, February 03, 2022**

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| 4:00pm-5:30pm | **Arithmetic Geometry Learning** -- Alex Perry ()  
*Unramified cohomology overview* -- 4096 East Hall | 4096 East Hall             |                                                                                 |

**Friday, February 04, 2022**

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| 1:00pm-2:00pm | **Representation Stability** -- ()  
*TBA* -- Online | Online                   |                                                                                 |
| 3:00pm-4:00pm | **Combinatorics** -- George Seelinger (University of Michigan)  
*A raising operator formula for nabla on an LLT polynomial* -- 4088 East Hall | 4088 East Hall             |                                                                                 |
| 3:00pm-4:00pm | **Student Algebraic Geometry** -- Sridhar Venkatesh (UM)  
*Rational curves through points in P^2* -- 2866 East Hall | 2866 East Hall             |                                                                                 |
| 4:00pm-4:50pm | **Learning Seminar in Representation Stability** -- Nick Wawrykow (UM)  
*Configuration spaces and secondary representation stability* -- 1866 East Hall | 1866 East Hall             |                                                                                 |
| 4:00pm-5:30pm | **Preprint Algebraic Geometry** -- Igor Dolgachev (UM)  
*Bloch's conjecture on 0-cycles* -- 4096 East Hall | 4096 East Hall             |                                                                                 |
| 4:00pm-5:00pm | **MCAIM Graduate Seminar** -- Michael Wadas (University of Michigan)  
*Formation and scaling of vortex rings generated from shock-accelerated interfaces* -- 2866 East Hall | 2866 East Hall             |                                                                                 |
Abstracts for the week of January 30th, 2022 - February 5th, 2022

RTG Seminar on Number Theory
Monday, January 31, 2022, 3:00pm-4:00pm
4088 East Hall
Tasho Kaletha (University of Michigan)

TBA

RTG Representation Theory
Monday, January 31, 2022, 3:00pm-5:15pm

Tasho Kaletha (UM)
Trace formula for SL2 and its stabilization

*** Please note the special time!! ***

Location: https://umich.zoom.us/j/96092436197.

Please note that there is no password, but umich log-in is required.

Complex Analysis, Dynamics and Geometry
Monday, January 31, 2022, 4:00pm-5:00pm
https://umich.zoom.us/j/97288641488 Virtual
Giulio Tiozzo (University of Toronto)
A global shadow lemma and logarithm law in Hilbert geometry

The asymptotic properties of cusp excursions in hyperbolic manifolds are famously quantified by Sullivan's logarithm law, which relates the depth of excursion with the Hausdorff dimension of the limit set. In this talk, we extend this work to Hilbert geometries, proving a global shadow lemma and a logarithm law for Patterson-Sullivan measures in geometrically finite Hilbert manifolds.

We also prove a Dirichlet-type theorem for hyperbolic metric spaces which have sufficiently regular Busemann functions. Joint work with Harry Bray.

https://umich.zoom.us/j/97288641488
The infamous Erdos-Szekeres Conjecture states that the number of points on a plane in general position with no \( n \) (greater than 1) points in convex position, called an \( n \)-gon, is at most \( 2^{\frac{n-2}{2}} \).

They later provided a construction \( S_n \) of exactly that many points avoiding any such \( n \)-gon.

Erdos, Tuza and Valtr discovered that, if the conjecture is true, the 'interval' subset \( S_{n,a,b} \) of the maximal construction \( S_n \) should also attain the maximum size while avoiding any \( n \)-gon, \( a \)-cap or \( b \)-cup for \( a, b \leq n \leq a + b - 4 \).

Here, an \( m \)-cap (or \( m \)-cup) is a point set of size \( m \) that can be connected by a graph of some concave (or convex) function.

Indeed, an abstract set-theoretic generalization by Peters and Szekeres was disproved by Balko and Valtr by showing that the set \( S_{n,n,4} \) is not maximal in this set-theoretic setting.

In this work, we show the optimality of \( S_{n,n,4} \) in the original geometric setting.

That is, \( (n-2) \) choose \( 2 + 2 \) points in a general position either determine a \( 4 \)-cap or \( n \)-gon.

It shows for the first time the optimality of a nontrivial subset of \( S_n \) not covered by the Erdos-Szekeres theorem on caps and cups.

The proof also generalizes to a set-theoretic setup slightly different from that of Peters and Szekeres, suggesting that the full conjecture may generalize in the same way.

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Donaldson-Thomas Theory
Monday, January 31, 2022, 4:00pm-5:30pm
4096 East Hall
James Hotchkiss
The intrinsic normal cone

Student Dynamics/Geometry Topology
Monday, January 31, 2022, 5:00pm-6:00pm
3866 East Hall

Lightning Talks! (Part 1)

All older graduate students in dynamics, geometry, and topology are invited to give ~5-10 minute "lightning talks" about one or more mathematical topics/questions/ideas they are interested in. Newer graduate students will have the opportunity to give their own lightning talks in two weeks.
Integrable Systems and Random Matrix Theory  
Monday, January 31, 2022, 9:00am-10:00am  
ZOOM ID: 926 6491 9790 Virtual  
Giulio Ruzza (Université Catholique de Louvain)  
Airy process and Korteweg-de Vries equation

I will report on joint works with M. Cafasso, C. Charlier, T. Claeys, in which we study a new class of Korteweg-de Vries solutions. They are built out of certain multiplicative expectations of the Airy point process and they generalize the self-similar solution associated with the Hastings-McLeod Painlevé II transcendent; in general they are associated with a specific solution, again characterized by an Airy limiting behavior, of an "integro-differential" generalization of the Painlevé II equation. The solutions are unbounded and the classical scattering-inverse scattering theory cannot be applied; however, they can be characterized through a Riemann-Hilbert problem, which allows to study rigorously and precisely their small time asymptotics, which we do uniformly in the space variable. A special case of the construction provides refined tail asymptotics for a specific solution ("narrow-wedge solution") of the Kardar-Parisi-Zhang stochastic equation. Depending on time I will comment on some more recent generalizations.

<b>A recording of the talk can be found <a href ="https://youtu.be/Q27q08dxffo">here</a>.</b>

Student Commutative Algebra  
Tuesday, February 01, 2022, 3:00pm-4:00pm  
3088 East Hall  
Teresa Yu (University of Michigan, Ann Arbor)  
Resolutions over hypersurface rings

Minimal free resolutions of finitely generated modules over a hypersurface ring (e.g., a polynomial ring over a field quotiented by a nonzero element) can be infinite, but they turn out to still have a finiteness aspect, as they always become periodic (of period 1 or 2) or terminate after finitely many steps. In this talk, we'll present a proof of this result by Eisenbud. Along the way, we'll discuss the relationships between periodic resolutions over hypersurface rings, matrix factorizations, and maximal Cohen-Macaulay modules.

This talk will also be livestreamed via Zoom.
Colloquium Series
Tuesday, February 01, 2022, 4:00pm-5:00pm

Sebastian Hurtado-Salazar (University of Chicago)
Volume vs Homotopy type for locally symmetric spaces

We discuss some open problems and some new results about the topology of arithmetic locally symmetric spaces. Among the new results is a proof of a conjecture of Gelander stating that the complexity of the topology of these manifolds can be bounded just in terms of the volume. The main new tool is an arithmetic refinement of the classical Margulis lemma about discrete subgroups of Lie groups. Based on joint work with Mikolaj Fraczyk and Jean Raimbault. All notions will be explained.

Learning Seminar in Algebraic Combinatorics
Wednesday, February 02, 2022, 2:30am-4:00pm
4096 East Hall
Thomas Lam (University of Michigan)
Cluster cohomology and knot homology

I will introduce some of the themes that will hopefully be discussed in the learning seminar this semester. The main thread is the (potential) relationship between the cohomology of cluster varieties and knot homology of links.
Financial/Actuarial Mathematics  
Wednesday, February 02, 2022, 4:00pm-5:00pm  
Zoom Virtual  
Soren Christensen (Christian-Albrechts-University Kiel)  
Learning to reflect - Data-driven solutions to singular control problems

Stochastic optimal control problems have a long tradition in applied probability, with the questions addressed being of high relevance in a multitude of fields. Even though theoretical solutions are well understood in many scenarios, their practicability suffers from the assumption of known dynamics of the underlying stochastic process, raising the statistical challenge of developing purely data-driven controls in a nonparametric framework.

In this talk, we will mainly concentrate on long-term average singular control problems for general Lévy processes on the real line. First, we present a method for solving such problems for known underlying dynamics in terms of the ladder height process. To construct a data-driven procedure, the fundamental observation is that this solution can be represented using an auxiliary function involving the stationary distribution of the overshoot process. This leads to the statistical question of finding rate-optimal estimators with respect to the sup-norm risk for such functionals. As a result, we present a fully data-driven strategy that is optimal on the long run and show that the regret per time unit is of order $1/\sqrt{T}$.

Algebraic Geometry  
Wednesday, February 02, 2022, 4:00pm-5:20pm  
4096 East Hall  
Jakub Witaszek (UM)  
Relative semiampleness in mixed characteristic

In my talk, I will explain some new results on the base point freeness of line bundles in mixed characteristic in connection with the work of Cascini-Tanaka on relative base-point-freeness in positive characteristic and Bhatt-Scholze on descending vector bundles up to perfection.

RTG Seminar on Geometry, Dynamics and Topology  
Wednesday, February 02, 2022, 4:00pm-5:30pm  
3866 East Hall  
Sebastian Hurtado (U Chicago)  
Height gaps for groups of matrices and almost laws

The famous “Tits alternative” states that a pair of matrices which generate a non-solvable group must contain a free group. Around 2008, Breuillard proved a strong version of this result by showing that a pair of (algebraic) matrices generating a non-solvable group must generate a matrix with large eigenvalues (in some valuation). We will discuss this theorem and some of its applications. We will also offer a new proof based on the existence of curious word maps known as almost laws. Joint work with Homin Lee and Lvzhou Chen.
Arithmetic Geometry Learning
Thursday, February 03, 2022, 4:00pm-5:30pm
4096 East Hall
Alex Perry ()
Unramified cohomology overview

Representation Stability
Friday, February 04, 2022, 1:00pm-2:00pm
Online
()
TBA

Combinatorics
Friday, February 04, 2022, 3:00pm-4:00pm
4088 East Hall
George Seelinger (University of Michigan)
A raising operator formula for nabla on an LLT polynomial

The operator nabla plays an important role in the theory of Macdonald polynomials and (q,t)-combinatorics. Over the past few decades, many combinatorial formulas for the image of various symmetric function bases under the nabla operator have been conjectured and eventually proven. The operator nabla also appeared in the study of the elliptic Hall algebra of Burban and Schiffmann, which is generated by subalgebras \( \Lambda(X^{m,n}) \) for coprime integers \( m,n \), each one isomorphic to the algebra of symmetric functions. Using a combinatorial construction, we identify certain rational functions that correspond to LLT polynomials in \( \Lambda(X^{m,n}) \). As a corollary, we recover a raising operator formula for nabla applied to an LLT polynomial, special cases of which include nabla applied to Schur function and nabla applied to a Hall-Littlewood polynomial. This work is joint with Jonah Blasiak, Mark Haiman, Jennifer Morse, and Anna Pun.

Student Algebraic Geometry
Friday, February 04, 2022, 3:00pm-4:00pm
2866 East Hall
Sridhar Venkatesh (UM)
Rational curves through points in \( P^2 \)

In this talk, we will discuss the proof of the fact that there are 12 rational curves through 8 general points in \( P^2 \). Time permitting, I will say a few words about Kontsevich's formula to calculate the number of degree \( d \) rational curves through \( 3d-1 \) general points in \( P^2 \). The talk will be accessible to anyone who has taken Math 631.
Learning Seminar in Representation Stability
Friday, February 04, 2022, 4:00pm-4:50pm
1866 East Hall
Nick Wawrykow (UM)
Configuration spaces and secondary representation stability

An ordered configuration space is the space of ways of putting labeled non-overlapping objects (points, disks, etc.) in another space (manifold, graph, etc.). Church, Ellenberg, and Farb and later Miller and Wilson proved that the sequence consisting of the k-th rational homology of the ordered configuration space of n points on a connected non-compact manifold of dimension at least 2 exhibits a type of stability, namely once you have at least n=2k points, this sequence stabilizes as a sequence of symmetric group representations. This is first order representation stability. Miller and Wilson proved that the unstable homology classes satisfy a notion of "secondary representation stability," that arises from adding a pair of orbiting points "near infinity". We will discuss their results, introducing the category FIM^+ and the arc resolution spectral sequence.

Preprint Algebraic Geometry
Friday, February 04, 2022, 4:00pm-5:30pm
4096 East Hall
Igor Dolgachev (UM)
Bloch's conjecture on 0-cycles
MCAIM Graduate Seminar  
**Friday, February 04, 2022, 4:00pm-5:00pm**  
2866 East Hall  
**Michael Wadas (University of Michigan)**  

*Formation and scaling of vortex rings generated from shock-accelerated interfaces*

Vortex rings are known to emerge in a variety of flows relevant to astrophysics, high energy density physics, and inertial confinement fusion, where they can significantly affect the flow through the transport of vorticity. We systematically study the generation and scaling of such rings utilizing a numerical platform involving a shock passing through an interface separating two dissimilar fluids along which there is a hole filled with the heavier fluid. As the shock passes through the interface, it deposits baroclinic vorticity that induces a complex phase inversion process ultimately resulting in the ejection of a ring from the hole. By modulating the aspect ratio of the hole, the amount of vorticity in the flow available to the ring is controlled. Based on the aspect ratio of the ring, we find that two distinct flow regimes emerge. For small aspect ratios, a single ring is generated that contains the majority of the vorticity deposited by the shock. Beyond a critical hole aspect ratio, however, the circulation of the ejected ring saturates, and the additional vorticity in the flow accumulates in a jet that trails the leading ring. This behavior suggests the existence of a fundamental formation number governing the scaling of rings generated from shock-accelerated interfaces, including those in Richtmyer-Meshkov flows.

This work is funded by the U.S. Department of Energy (DOE) NNSA Center of Excellence under cooperative agreement number DE-NA0003869 and by the U.S. DOE NNSA Stewardship Science Graduate Fellowship under grant DE-NA0003960.