### Weekly Seminar & Events Bulletin
**September 18th, 2022 - September 24th, 2022**

#### Monday, September 19, 2022

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<td><strong>Logic</strong> -- William Mance (Adam Mickiewicz University, Poznan) <strong>Descriptive complexity in number theory and dynamics</strong> -- 3088 East Hall</td>
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<td><strong>Commutative Algebra</strong> -- Byeongsu Yu (Texas A&amp;M University) <strong>When are ( \mathbb{Z}[d] )-graded modules of affine semigroup rings Cohen-Macaulay</strong> -- <a href="https://umich.zoom.us/j/96274532499">https://umich.zoom.us/j/96274532499</a> (password: algebra) Virtual East Hall</td>
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RTG Seminar on Number Theory
Monday, September 19, 2022, 3:00pm-4:15pm
4088 East Hall
Robert Cass (UM)

Structure theory of homogeneous spherical varieties

This is a learning seminar on the relative Langlands program. The focus of the seminar in Fall 2022 will be on the Sakellaridis–Venkatesh conjectures. We meet 3:00-4:15p on Mondays in EH 4088. Talks will run around 60 minutes, with the remaining time left for questions, comments, and discussion. All are invited to attend, and participation by graduate students and postdocs is especially encouraged. If you would like to give a talk in the seminar, please let one of the organizers know. The full schedule can be found at:

http://www-personal.umich.edu/~charchan/seminar/

Complex Analysis, Dynamics and Geometry
Monday, September 19, 2022, 4:00pm-5:00pm
3096 East Hall
Alex Kapiamba (U(M))

Elephants all the way down: the near-parabolic geometry of the Mandelbrot set

Understanding the geometry of The Mandelbrot set, which records dynamical information about every quadratic polynomial, has been a central task in holomorphic dynamics over the past forty years. Near parabolic parameters, the structure of the Mandelbrot set is asymptotically self-similar and resembles a parade of elephants. Near parabolic parameters on these “elephants”, the Mandelbrot set is again self-similar and resembles another parade of elephants. This phenomenon repeats infinitely, and we see different parades of elephants at each scale. In this talk, we will explore the implications of controlling the geometry of these elephants. In particular, we will partially answer Milnor’s conjecture on the optimality of the Yoccoz inequality, and see potential connections to the local connectivity of the Mandelbrot set.
Integrable Systems and Random Matrix Theory  
**Monday, September 19, 2022, 4:00pm-5:00pm**

**ZOOM ID: 926 6491 9790 Virtual**

Liying Li (University of Michigan)  
*Stationary solutions for 1D Burgers equations and KPZ scaling*

In the first part, we will talk about the stationary solutions for 1D stochastic Burgers equations and their ergodic properties. We will classify all the ergodic components, establish the "one force---one solution" principle, and obtain the inviscid limit. The key objects to study are the infinite geodesics and infinite-volume polymer measures in random environments, and the ergodic results have their counterparts in the geodesic/polymer language. In the second part, we will present a random point field model that is motivated by the coalescing and monotone structure of the optimal paths in random environments that arise in many KPZ models. The 2/3 transversal exponent from the KPZ scaling becomes a natural parameter for the renormalization action in this model, and can be potentially extended to values other than 2/3. Some preliminary results are given.

**Student Combinatorics**  
**Monday, September 19, 2022, 4:00pm-5:00pm**

3866 East Hall  

Scott Neville (University of Michigan)  
*Some Colourful Convexity Theorems*

Consider a point in the plane, and draw three triangles, each of a different colour, containing your point. The colourful Caratheodory's theorem states that your point is contained in a rainbow triangle, made by taking one vertex from each triangle you drew. In this talk, we will state and prove the monochrome and colourful Caratheodory's theorem, as well as some applications of this vibrant theorem.

**Group, Lie and Number Theory**  
**Monday, September 19, 2022, 4:30pm-5:30pm**

4088 East Hall  

Alberto Minguez (University of Vienna)  
*The explicit Zelevinsky-Aubert involution*

Let F be a local non-archimedean field. In 1980, A. Zelevinsky defined an involution pi -> pi^t in the Grothendieck group of finite length complex smooth representations of GL(n,F) and conjectured that this involution preserves irreducibility. A.-M. Aubert showed that Zelevinsky's definition can be extended to the Grothendieck group of finite length complex smooth representations of any connected reductive p-adic group G and proved that the involution preserves irreducibility. In 1986, C. Moeglin et J.-L. Waldspurger gave an algorithm to compute the Langlands parameters of pi^t in terms of the parameters of pi in the case where pi is an irreducible representation of GL(n,F). In this talk I will treat the case where G is the group Sp(2n,F) or SO(2n+1,F). It is a joint work with H. Atobe.
Student Commutative Algebra  
**Tuesday, September 20, 2022, 3:00pm-4:00pm**  
3866 East Hall  
**Jonghyun Lee (UM)**  
*Introduction to derived categories and some applications to commutative algebra*

In this talk we give an informal introduction to the derived category as well as some applications to commutative algebra, e.g. Auslander-Buschbaum formula and the homological characterization of depth, time permitting.

Colloquium Series  
**Tuesday, September 20, 2022, 4:00pm-5:00pm**  
1360 East Hall  
**Moon Duchin (Tufts University)**  
*Random Trees*

Graphs and networks encode many kinds of useful structures from abstract as well as practical applications. If we want to divide a graph into connected parts, a spanning tree is a natural device because deleting a single edge will induce a connected bipartition. Despite a huge literature on spanning trees supported by lots of fast algorithms, many basic questions are still wide open. I'll talk about spindly trees, bushy trees, and applications to civil rights.

Zoom link: https://umich.zoom.us/j/92772750713

Student Analysis  
**Tuesday, September 20, 2022, 5:00pm-6:00pm**  
3096 East Hall  
**Tejaswi Tripathi (University of Michigan)**  
*Method of Moments*

In probability theory, the method of moments is a way of proving convergence in distribution by proving convergence of a sequence of moment sequences. This method was introduced by Chebyshev for proving the Central Limit Theorem (CLT). In this talk, I will introduce the method of moments and then apply it to prove CLT. Time permitting, we'll briefly discuss the proof of Wigner's Semicircle Law for Random Matrices.
Learning Seminar in Algebraic Combinatorics  
Wednesday, September 21, 2022, 2:30pm-4:00pm  
4088 East Hall  
Yibo Gao (University of Michigan)  
*Discrete surfaces from dimer coverings and Kasteleyn's theorem*

We first set up some preliminaries on graph homology and explain how to generate a discrete surface from a dimer covering. Then we prove Kasteleyn's theorem, which expresses the partition function of a planar dimer model as a determinant.

**Student Arithmetic**  
**Wednesday, September 21, 2022, 3:00pm-4:00pm**  
**1866 East Hall**  
**Andy Jiang (UM)**  
*A Galois group computation by Coleman*

I will compute the Galois group of a particular polynomial using a method by Coleman.

**Algebraic Geometry**  
**Wednesday, September 21, 2022, 4:00pm-5:30pm**  
**4096 East Hall**  
**Eric Larson (Brown)**  
*Interpolation for Brill-Noether Curves*

In this talk, we determine when there is a Brill-Noether curve of given degree and given genus that passes through a given number of general points in any projective space.
Financial/Actuarial Mathematics  
Wednesday, September 21, 2022, 4:00pm-5:00pm  
1360 East Hall  
Purba Das (UM)  
*On pathwise quadratic variation*

We study the concept of quadratic variation of a continuous path along a sequence of partitions and its dependence with respect to the choice of the partition sequence. We define the concept of quadratic roughness of a path and show that, for Hölder-continuous paths satisfying this roughness condition, the quadratic variation along balanced partitions is invariant with respect to the choice of the partition sequence. Using these results we derive a formulation of Föllmer’s pathwise integration along paths with finite quadratic variation which is invariant with respect to the partition sequence.

We present several constructions of paths and processes with finite quadratic variation along a refining sequence of partitions, extending previous constructions to the non-uniform case. We study in particular the dependence of quadratic variation with respect to the sequence of partitions for these constructions. We identify a class of paths whose quadratic variation along a partition sequence is invariant under coarsening.

Geometry  
Wednesday, September 21, 2022, 4:00pm-5:30pm  
3866 East Hall  
Teddy Weisman (U Michigan)  
*Ping-Pong, Automata and Stability for Hyperbolic Group Actions*
Informally, a real number is normal in base $b$ if in its $b$-ary expansion, all digits and blocks of digits occur as often as one would expect them to, uniformly at random. Kechris asked several questions involving descriptive complexity of sets of normal numbers. The first of these was resolved in 1994 when Ki and Linton proved that the set of numbers normal in base $b$ is $\Pi^0_3$-complete. Further questions were resolved by Becher and Slaman. Many of the techniques used in these proofs can be used elsewhere. We will discuss recent results where similar techniques were applied to solve a problem of Sharkovsky and Sivak and a question of Kolyada, Misuurewicz, and Snoha. Furthermore, we will discuss a recent result where the set of numbers that are continued fraction normal, but not normal in any base $b$, was shown to be complete at the expected level of $D_2(\Pi^0_3)$. An immediate corollary is that this set is uncountable, a result (due to Vandehey) only known previously assuming the generalized Riemann hypothesis.

Special Events
Thursday, September 22, 2022, 11:30am-12:50pm
Tables outside Shapiro

As a reading, I am suggesting that we read the first chapter of this new book by Sathy and Hogan on Inclusive Teaching.

https://search.lib.umich.edu/catalog/record/99187625352706381

This is departing a bit from my promised plan, but I think this is a great starting point for a new semester together. As always, do the reading if you can, but please show up for a good discussion whether or not you had time to complete the reading.

As long as the weather forecast stays clear, we'll meet at the group of tables outside of Shapiro (between Hatcher & Clements). I'll try to show up a bit early to snap some tables. Or if they're all taken, we can sit in the grass. (Please let me know if you have any mobility issues that will make ground-sitting difficult!). I do not have any budget this year for lunch, so please bring your own.

All are welcome to this discussion and I look forward---especially---to meeting new members of our department.

Nina
Commutative Algebra  
Thursday, September 22, 2022, 3:00pm-4:00pm  
https://umich.zoom.us/j/96274532499 (password: algebra) Virtual East Hall  
Byeongsu Yu (Texas A&M University)  
When are $\mathbb{Z}^{d}$-graded modules of affine semigroup rings Cohen-Macaulay

We give a new combinatorial criterion for $\mathbb{Z}^{d}$-graded modules of affine semigroup rings to be Cohen-Macaulay, by computing the homology of finitely many polyhedral complexes. This provides a common generalization of well-known criteria for affine semigroup rings and monomial ideals in polynomial rings. We also introduce its application on the graded modules over a quotient ring of the polynomial ring by a lattice or cellular binomial ideal if time permits. This is joint work with Laura Matusevich.

Differential Equations  
Thursday, September 22, 2022, 4:00pm-5:00pm  
4088 East Hall  
Christopher DiScenza (Michigan)  
Kinetics and Resonance Analysis of Nearshore Edge Waves

The evolution of edge waves in the nearshore provides an interesting example of a mixed spectrum boundary value problem. Using the Hamiltonian formulation with the shallow water model we construct a kinetic equation for three wave resonant interactions and determine a Kolmogorov-Zakharov spectrum for the example of a simple beach profile. This example also yields an algebraic model of the resonance manifold.

Arithmetic Geometry Learning  
Thursday, September 22, 2022, 4:00pm-12:00am  
4096 East Hall  
Ethan Huffman ()  
Brauer groups
Mathematics Communications  
**Thursday, September 22, 2022, 4:00pm-5:00pm**  
1866 East Hall  
Sam Hansen (University of Michigan, Ann Arbor)  
*What, How, and Why: The First Meeting of the Mathematics Communication Seminar*

In this, the first ever meeting of the Mathematics Communication Seminar, we will have a planning conversation followed by a discussion about the what mathematics communication encompasses, how it is done, and why we do it. To frame this discussion please read "The Role of Mathematicians in Popularization of Mathematics" by Christiane Rousseau and "Communicating Mathematics to Society at Large" by Günter Ziegler from the Proceedings of the ICM 2010. (You can find all readings for this seminar at https://tinyurl.com/mathCommSemF22)

Student Dynamics/Geometry Topology  
**Thursday, September 22, 2022, 4:00pm-5:00pm**  
3096 East Hall  
DGT attendees ()  
*Lightning talks II*

This is the second session of lightning talks for the semester. The speakers will speak for 5-10 minutes on something they are working on/thinking about/or excited about.
Applied Interdisciplinary Mathematics (AIM)
Friday, September 23, 2022, 3:00pm-4:00pm
1084 East Hall
Peng Wang (University of Michigan)
A Geometric Analysis of Neural Collapse with Normalized Features

When training overparameterized deep networks for classification tasks, it has been widely observed that the learned features exhibit a so-called "neural collapse" phenomenon. More specifically, for the output features of the penultimate layer, the within-class features converge to their means for each class, and the means of different classes exhibit a certain tight frame structure, which is also aligned with the last layer's classifier. As feature normalization in the last layer becomes a common practice in modern representation learning, we theoretically justify the neural collapse phenomenon for normalized features in this work. Based on an unconstrained feature model, we simplify the empirical loss function in a multi-class classification task and obtain a nonconvex optimization problem over the Riemannian manifold by constraining all features and classifiers over the sphere. In this context, we analyze the nonconvex landscape of the Riemannian optimization problem over the product of spheres, showing a benign global landscape in the sense that the only global minimizers are the neural collapse solutions while all other critical points are strict saddles with negative curvature.

Combinatorics
Friday, September 23, 2022, 3:00pm-4:00pm
4088 East Hall
Daniil Rudenko (University of Chicago)
Cluster Polylogarithms

I will start with a brief introduction to polylogarithms and the Goncharov Program. Next, I will define cluster polylogarithms associated with an arbitrary cluster algebra and describe their classification in type A. Then I will explain, how cluster polylogarithms can be used to prove an "unobstructed" part of the Goncharov depth conjecture.

Student Algebraic Geometry
Friday, September 23, 2022, 3:00pm-3:50pm
2866 East Hall
Yueqiao Wu (Michigan)
Toric Varieties

Toric varieties form an important class of algebraic varieties whose geometry is encoded in combinatorial objects, and are thus testing examples for many general theories. This talk aims to give a gentle introduction to toric varieties. The talk will be accessible to anyone who has seen the construction of a real/complex projective space.
In his celebrated thesis, Margulis showed how to use a mixing property of the geodesic flow to obtain several kinds of equidistribution results for negatively curved closed Riemannian manifolds. More precisely the results concern equidistribution of closed geodesics and of orbits of the fundamental group in the universal cover. Margulis’ ideas have been extended to more general geometric settings, with not necessarily compact spaces, for instance by Roblin who worked on non-compact locally CAT(-1)-spaces.

In this talk, we will consider similar questions in another geometric setting: that of convex projective manifolds, i.e. quotients of a properly convex domain of a real projective space. These manifolds appear in particular in the study of some discrete subgroups of Lie groups, and equidistribution results presented here are related to equidistribution results due to Sambarino for Anosov representations.

Convex projective manifolds naturally carry a Finsler metric (the Hilbert metric) which is in general not locally CAT(0). The projective lines are geodesics for this metric, and are parametrised by a geodesic flow. The study of the dynamics of this flow that we will present is joint work with Feng Zhu.