## Weekly Seminar & Events Bulletin
### February 23rd, 2020 - February 29th, 2020

### Monday, February 24, 2020

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Friday, February 28, 2020

12:00pm-1:00pm  **Student Homotopy Theory** -- Andy Jiang (University of Michigan) *Why Tr(AB) = Tr(BA)* -- 3096 East Hall

3:00pm-4:00pm  **Applied Interdisciplinary Mathematics (AIM)** -- Sarah Olson (Worcester Polytechnic Institute) *Sperm navigation in complex environments* -- 1084 East Hall

3:00pm-4:00pm  **Student Commutative Algebra** -- Zhan Jiang (University of Michigan) *F-signatures* -- 3088 East Hall

4:00pm-5:30pm  **Junior Colloquium Series** -- UM PhD Alumni (various) *Non-Academic Careers Panel* -- 1068 East Hall

4:00pm-5:20pm  **Preprint Algebraic Geometry** -- Yueqiao Wu (UM) *Non-reductive geometric invariant theory and hyperbolicity, following Berczi and Kirwan* -- 4096 East Hall
Abstracts for the week of February 23rd, 2020 - February 29th, 2020

**Student Dynamics**
**Monday, February 24, 2020, 3:00pm-3:50pm**
3866 East Hall
Chris Zhang (UM)

*Pseudo Anosov Homeomorphisms*

We define pseudo Anosov homeomorphisms and describe some things about their geometry and dynamics. We draw parallels between these maps and hyperbolic isometries of the upper half plane. We hope this talk is approachable to a wide audience.

**Student Combinatorics**
**Monday, February 24, 2020, 3:00pm-4:00pm**
3088 East Hall
Scott Neville (UM)

*Longest Increasing Subsequences and Kostka Numbers*

A classical bijection relates the Catalan numbers and permutations of length $n$ with longest increasing subsequence (LIS) of length at most 2. I'll discuss the major elements of this classical bijection, as well as joint work with Arjun Krishnan, in which we generalize this bijection and find Kostka numbers which count the number of permutations of $n$ with LIS length at most $w$, and similar sets of restricted permutations.

**Integrable Systems and Random Matrix Theory**
**Monday, February 24, 2020, 4:00pm-5:00pm**
1866 East Hall
Lu Wei (University of Michigan)

*Average entanglement entropies over the Bures-Hall measure*

We present explicit finite size results on the mean quantum purity and von Neumann entropy over the Bures-Hall measure. A key ingredient of the calculations is the recently discovered connection between the correlation functions of Bures-Hall ensemble and these of the Cauchy-Laguerre biorthogonal ensemble. (This talk is based on the preprint arXiv:2002.04085.)
Group, Lie and Number Theory  
Monday, February 24, 2020, 4:10pm-5:00pm  
4096 East Hall  
Spencer Leslie (Duke University)  
*The endoscopic fundamental lemma for unitary Friedberg-Jacquet periods*

I will discuss a theory of endoscopy for certain symmetric spaces associated to unitary groups, the main result being the fundamental lemma for the "Lie algebra". This is motivated by the study of certain periods of automorphic forms on unitary groups with applications to arithmetic. After explaining where the fundamental lemma fits into this broader picture, I will describe its proof if time permits.

Student Analysis  
Monday, February 24, 2020, 5:00pm-6:00pm  
4088 East Hall  
Christopher Stith (University of Michigan)  
*The Cauchy problem for the (vacuum) Einstein equations*

The Einstein equations are a system of PDE governing the curvature of a pseudo-Riemannian manifold. It is natural to ask if these equations have a formulation as an initial value problem, and if they can be solved in this context. In this talk we will discuss Choquet-Bruhat's work on the subject, covering the main steps in her argument proving existence and uniqueness results for the vacuum Einstein equations given appropriate initial data. We will briefly review relevant definitions from differential geometry.

IBL Workshops/Lectures  
Tuesday, February 25, 2020, 11:30am-1:00pm  
3088 East Hall

*IBL Lunch*

The IBL Lunch will be in a different location this week (3088 EH) from 11:30-1pm. You should feel free to come for any length of time. Lunch will be provided.
Student Geometry/Topology
Tuesday, February 25, 2020, 3:00pm-4:00pm
1866 East Hall
Konstantinos Tsouvalas (UM)
Some constructions of word hyperbolic groups

Word hyperbolic groups form a rich class of finitely presented groups. Classical examples of word hyperbolic groups include closed surface groups and more generally fundamental groups of closed negatively curved Riemannian manifolds. In this talk, we are going to discuss some finiteness properties of word hyperbolic groups and describe several examples based on combination theorems and the Rips construction.

Student Algebraic Geometry
Tuesday, February 25, 2020, 3:00pm-4:00pm
B745 East Hall
Carsten Sprunger (UM)
27 lines via intersection theory

Attempting to understand the well-known classical problem of counting lines on a smooth cubic surface in the projective space $\mathbb{P}^3$ can lead to some very interesting ideas. In this talk, we will walk through a solution to this problem, primarily as a way to introduce and demonstrate the usefulness of some basic elements of intersection theory which will come up along the way. No prior knowledge of intersection theory is assumed - we will give a basic description of how an intersection theory should behave, take its existence as known, and use only a few fundamental axioms.

Colloquium Series
Tuesday, February 25, 2020, 4:00pm-5:00pm
1360 East Hall
Karen Parshall (University of Virginia)
Growing Research-Level Mathematics in 1930s America?: An Historical Paradox

World War I had marked a break in business as usual within the American mathematical research community. In its aftermath, there was a strong sense of entering into "a new era in the development of our science." And then the stock market crashed. Would it be possible in such newly straitened times to sustain into the 1930s the momentum that American mathematicians had managed to build in the 1920s? This talk will explore the contours of an answer to that question.
Student Arithmetic
Wednesday, February 26, 2020, 3:00pm-4:00pm
3088 East Hall
Lukas Scheiwiller (University of Michigan)

*Gentle introduction to Sites and the Étale Cohomology*

We will begin by defining Sites, which is a generalization of a topology, and study sheaves on them. This will lead to the definition of the Étale cohomology. We will see that this is in fact a cohomology we can actually compute and see some examples, trying to demystify this cohomology. Knowledge corresponding to the current Math 632 level will be more than enough, in fact only the theory of derived functors will be a prerequisite.

Financial/Actuarial Mathematics
Wednesday, February 26, 2020, 4:00pm-5:00pm
1360 East Hall
Leo Neufcourt (MSU)

*Continuous expansion of a filtration with a stochastic process: the information drift.*

In this joint work with Philip Protter we consider a general market with a semimartingale asset price and study the situation where an "insider" agent has access to a continuous flow of additional information generated by a stochastic process. Assuming no arbitrage conditions, the price process remains a semimartingale for the expanded filtration; it is then characterized by an (additional) information drift. The information drift is a key proxy to the statistical advantage provided by the additional information. The core of our results consists in a series of convergence theorems for semimartingale decompositions based on $L^p$ norms, which provides a representation of the information drift for continuous expansions. These tools are employed to study a new class of models for the information accessible to high-frequency traders.
Algebraic Geometry
Wednesday, February 26, 2020, 4:00pm-5:20pm
4096 East Hall
Enrica Mazzon (Max Planck Institute)
Non-archimedean approach to mirror symmetry and to degenerations of hyper-Kaehler varieties

Mirror symmetry is a fast-moving research area at the boundary between mathematics and theoretical physics. Originated from observations in string theory, it suggests that complex Calabi-Yau manifolds should come in mirror pairs, in the sense that geometrical information of a Calabi-Yau manifold can be read through invariants of its mirror.

In the first part of the talk, I will introduce some geometrical ideas inspired by mirror symmetry. In particular, I will go through the main steps which relate mirror symmetry to non-archimedean geometry and the theory of Berkovich spaces.

In the second part, I will describe a combinatorial object which emerges in mirror symmetry and in birational geometry, the so-called dual complex of degeneration of varieties. I will show how the techniques of Berkovich geometry give a new insight into the study of dual complexes. In a joint work with Morgan Brown, we determine the homeomorphism type of the dual complex of some degenerations of hyper-Kaehler manifolds. The results are in accordance with the predictions of mirror symmetry, and the recent work about the rational homology of dual complexes of degenerations of hyper-Kaehler varieties, due to Kollar, Laza, Sacca and Voisin.

RTG Seminar on Geometry, Dynamics and Topology
Wednesday, February 26, 2020, 4:00pm-5:30pm
3866 East Hall
Asaf Katz (U Chicago)
Asaf Katz (U Chicago): Measure rigidity of Anosov flows via the factorization method.

Anosov flows are central objects in dynamics, generalizing the basic example of a geodesic flow over a Riemann surface.

In the talk we will introduce those flows and their dynamical behavior. Moreover, we show how the factorization method, pioneered by Eskin and Mirzakhani in their groundbreaking work about measure rigidity for the moduli space of translation surfaces, can be adapted to smooth ergodic theory and in particular towards the study of Anosov flows.

Using this adaption, we show that for a quantitatively non-integrable Anosov flow, every generalized u-Gibbs measure is absolutely continuous with respect to the whole unstable manifold.

In the talk I will introduce the concept, the relations to previous works (Eskin-Mirzakhani, Eskin-Lindenstrauss) and the result with some applications. Technical details will be given on the Thursday seminar.
Student Representation Theory  
Wednesday, February 26, 2020, 4:00pm-5:00pm  
2866 East Hall  
Will Dana (University of Michigan)  
Almost Split Sequences and Different Flavors of Finiteness

Questions about classifying the ways a particular configuration of linear maps can behave often come down to the representation theory of finite-dimensional algebras over a field. In studying this, we might wonder whether the finite-dimensionality is reflected in other kinds of nice finiteness in the representation category. This is true in a few ways, but false in many others: in particular, such an algebra may still have infinitely many indecomposable representations.

Nonetheless, there is a profound contrast between finite-dimensional algebras with finitely many indecomposables, and those with infinitely many: in the former case, the indecomposables can be nicely organized in a graph called the Auslander-Reiten quiver, while in the latter case, there should be no bound on their length (the substance of the now-proven Brauer-Thrall conjectures). This talk will introduce one of the key tools in drawing this dichotomy: almost split sequences, which are exact sequences that are as close as possible to split without actually being split.

Topology  
Thursday, February 27, 2020, 3:00pm-4:00pm  
3866 East Hall  
Asaf Katz (University of Chicago)  
The factorization method

The factorization method is a technical method, which allows one to choose generic points satisfying the constraints needed for the Eskin-Mirzakhani technique, overcoming some difficulties arising in the settings of smooth dynamics world compared to homogeneous dynamics. In the lecture, I will introduce the factorization theorem and ideas in its proof.

Moreover I will discuss how one can combine this technique together with the usage of normal forms coordinates, developed by Katok and Kalinin-Sadovskaya, in order to deduce measure rigidity results in smooth dynamics.
Commutative Algebra  
Thursday, February 27, 2020, 3:00pm-4:00pm  
1866EH East Hall  
Kenta Sato (iTHMS, Riken)  
On accumulation points of $F$-pure thresholds on regular local rings

Blickle, Mustata and Smith proposed two conjectures on the limits of $F$-pure thresholds. One conjecture asks whether or not the limit of a sequence of $F$-pure thresholds of principal ideals on regular local rings of fixed dimension can be written as an $F$-pure threshold in lower dimension. Another conjecture predicts that any $F$-pure threshold of a formal power series can be written as the $F$-pure threshold of a polynomial. In this talk, we prove that the first conjecture has a counterexample but a weaker statement still holds. We also give a partial affirmative answer to the second conjecture.

Student Homotopy Theory  
Friday, February 28, 2020, 12:00pm-1:00pm  
3096 East Hall  
Andy Jiang (University of Michigan)  
Why $Tr(AB) = Tr(BA)$

I will discuss how the concept of trace arises naturally in homotopy theory and its relationship with Hochschild homology. Hint: it has something to do with a circle.

Applied Interdisciplinary Mathematics (AIM)  
Friday, February 28, 2020, 3:00pm-4:00pm  
1084 East Hall  
Sarah Olson (Worcester Polytechnic Institute)  
Sperm navigation in complex environments

Microorganisms can swim in a variety of environments, interacting with chemicals and other proteins in the fluid. In this talk, we will highlight recent computational methods and results for swimming efficiency and hydrodynamic interactions of swimmers in different fluid environments. Sperm are modeled via a centerline representation where forces are solved for using elastic rod theory. The method of regularized Stokeslets is used to solve the fluid-structure interaction where emergent swimming speeds can be compared to asymptotic analysis. In the case of fluids with extra proteins or cells that may act as friction, swimming speeds may be enhanced and attraction may not occur.
For Noetherian local rings with prime characteristic $p>0$, there is a very important numerical invariant, called the $F$-signature. It roughly characterizes the asymptotic growth of the number of free direct summands in the Frobenius push-forward. This invariant was formally defined by C. Huneke and G. Leuschke and was shown existence by K. Tucker. I will introduce this notion and discuss its behavior on a special kind of rings, Hibi rings.

In this very popular event, we bring back UM Math PhD alumni who are working in industry to discuss their careers and paths in a panel format. This year, in celebration of the data revolution which has generated the current hunger for PhD level mathematicians in non-academic spaces, our panelists are all recent PhDs from our department working in various industries and positions related to DATA.

Panelists are Tigran Ananyan (Software Development Manager, Altair Engineering), Ross Kravitz (Data Scientist at Stripe), Hunter Brooks (Principal Data Scientist at Oracle Data Cloud (Moat)), Becky Hoai (data consultant at Slalom), Alex Mueller (Founder and CEO, Capnion).

Reception to follow immediately.

Non-reductive geometric invariant theory and hyperbolicity, following Berczi and Kirwan