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Abstracts for the week of February 9th, 2020 - February 15th, 2020

**Student Dynamics**
**Monday, February 10, 2020, 3:00pm-3:50pm**
1866 East Hall
Karen Butt (UM)

*Topological Entropy for Geodesic Flows*

I will explain the proofs of two results of Manning relating the topological entropy of the geodesic flow to the volume growth entropy. I will review the relevant geometric and dynamical concepts and the proofs will be self-contained. This talk should be understandable to anyone with some familiarity with differential topology and covering spaces.

**Student Combinatorics**
**Monday, February 10, 2020, 3:00pm-4:00pm**
3088 East Hall
Robert Cochrane (UM)

*Unimodal and Log-concave Sequences*

We say a finite sequence is unimodal if it can be split into a monotonically increasing sequence followed by a monotonically decreasing one. Many interesting sequences arising in combinatorics are unimodal - for example, the rows of Pascal's triangle are all unimodal. In most cases we are interested in, a sufficient condition for unimodality is log-concavity, and for some sequences this is easier to show. This talk, based on an old survey paper by Stanley, will cover the definitions of log-concavity and unimodality, introduce some interesting examples of such sequences, and explore how one might show that these sequences are log-concave and/or unimodal.

**Group, Lie and Number Theory**
**Monday, February 10, 2020, 4:10pm-5:00pm**
4096 East Hall
Ari Shnidman (Hebrew University)

*Higher order derivatives of L-functions and Manin-Drinfeld cycles*

I'll present a formula relating the r-th central derivative of an automorphic L-function for PGL_2 over a function field to the intersection of a pair of algebraic cycles. The intersection is between the Heegner-Drinfeld cycle considered by Yun-Zhang and a "Manin-Drinfeld" cycle of shtukas coming from the split torus. When the analytic rank is greater than 0, the formula implies that the intersection pairing vanishes, suggesting that these Manin-Drinfeld cycles may be torsion in the Chow group.
Student Algebraic Geometry
Tuesday, February 11, 2020, 3:00pm-4:00pm
B745 East Hall
Shubhodip Mondal (UM)
Higher algebraic K-theory

K-theory was defined by Grothendieck in 1950s which turned out to be extremely useful in the study of intersection theory for example. In this talk, we will define the higher K groups K_n for every n, where K_0 would be the K-group defined by Grothendieck. Our definition will follow Quillen’s plus construction. We will also mention how to construct the higher K groups using infinity categories.

Colloquium Series
Tuesday, February 11, 2020, 4:00pm-5:00pm
1360 East Hall
Kristen Hendricks (Rutgers University)
New invariants of homology cobordism

This is a talk about 3-manifolds and knots. We will begin by reviewing some basic constructions and motivations in low-dimensional topology, and will then introduce the homology cobordism group, the group of 3-manifolds with the same homology as the 3-dimensional sphere up to a reasonable notion of equivalence. We will discuss what is known about the structure of this group and its connection to higher dimensional topology. We will then discuss some existing invariants of the homology cobordism group coming from gauge theory and symplectic geometry, particularly Floer theory. Finally, we will introduce a new invariant of homology cobordism coming from an equivariant version of the computationally-friendly Floer-theoretic 3-manifold invariant Heegaard Floer homology, and use it to construct a new filtration on the homology cobordism group and derive some structural applications. Parts of this talk are joint work with C. Manolescu and I. Zemke; more recent parts of this talk are joint work with J. Hom and T. Lidman.

Student Arithmetic
Wednesday, February 12, 2020, 3:00pm-4:00pm
3088 East Hall
Andy Gordon (University of Michigan)
Introduction to Witt Vectors

The focus of this talk is to introduce and motivate the ring of Witt vectors (which is actually a ring-valued functor). With a heavy focus on examples, we will work through the construction of the Witt functor and describe the properties it satisfies, then spend the remainder of the talk describing reasons why one would want such a thing, and list applications in a variety of fields (including both varieties and fields)
Here, consider a constrained mean-field game where the price is determined by a supply vs. demand balance condition. We begin by examining problems with a deterministic supply. In this case, we establish the existence of a unique solution using a fixed-point argument. In particular, we show that the price is well-defined, and it is a Lipschitz function of time. Then, we study linear-quadratic models that can be solved explicitly. Finally, we discuss the case where the supply is a random process and in the case of linear-quadratic models discuss how to solve the problem.

Algebraic Geometry
Wednesday, February 12, 2020, 4:00pm-5:20pm
4096 East Hall
Michael Kemeny (University of Wisconsin)
A very simple proof of Voisin's theorem on canonical curves

The classical theorems of Noether and Petri on the ideals of canonically embedded curves are central in the theory of curves. In the 80s, Mark Green realized that these results should extend to a far broader statement about the entire resolution of the ideal. No major progress was made until Voisin resolved this conjecture for generic curves in 02 and 05. Voisin's proof was extremely sophisticated and uses in a deep way the geometry of the situation. We will give a very simple and short proof of her result, using nothing more than the basic yoga developed by Green, Ein and Lazarsfeld in the 80s. In the case of even genus, we will show how the proof our resolves a deeper (and previously open) conjecture, due to Schreyer, describing in depth the structure of the extremal syzygy space.

RTG Seminar on Geometry, Dynamics and Topology
Wednesday, February 12, 2020, 4:00pm-5:30pm
3866 East Hall
Ralf Spatzier (U Michigan)
Question and (Maybe) Answer Session on Superrigidity

As we have at least three talk (series) about superrigidity and applications, I would like to give an introduction to the topic, to the extent I understand/remember. Rather having a prepared talk, let's just have a question and answer session. Welcome to all with questions - answers.
Hochster and Huneke defined quasilength for any $I$-torsion modules, generalizing the notion of length to any non-maximal ideal $I$. Based on quasilength, we develop a new numerical invariant for ideals, called "size". It is invariant up to taking radicals and bounded between the arithmetic rank and height of the ideal. We will present some results in low dimensions and discuss a lot of open questions related to "size" and asymptotical behaviors of quasilength.

Differential Equations
Thursday, February 13, 2020, 4:00pm-5:00pm
4088 East Hall
Hui Zhu (University of Michigan, Ann Arbor)
Propagation of singularities for gravity-capillary waves, Part II

The surface tension makes free surfaces of fluids instantaneously smooth. For 2D gravity-capillary water waves, this phenomenon has been justified by Christianson-Hur-Staffilani and Alazard-Burq-Zuily as local smoothing effects.
In this talk, I will present a microlocal justification of this phenomenon for gravity-capillary water waves in arbitrary dimensions. My main results are two propagation theorems for some quasi-homogeneous wavefront sets of gravity-capillary water waves.

Student Homotopy Theory
Friday, February 14, 2020, 12:00pm-1:00pm
3096 East Hall
Jack Carlisle (University of Michigan)
Equivariant formal group laws and their duals.

If $E$ is a complex-oriented spectrum, then the $E$-cohomology of $BU(1)$ has the structure of a formal group law over $E_*$. If $E = MU$ is the complex cobordism spectrum, then Quillen's theorem asserts that the formal group law over $MU_*$ is the universal formal group law.

Suppose that $G$ is a compact Lie group. If $E$ is a complex-oriented $G$-spectrum, then the $E$-cohomology of the equivariant classifying space $BU_G(1)$ has the structure of a $G$-equivariant formal group law. This is an algebraic structure that corresponds geometrically to a formal thickening of the character group of $G$. After reviewing the non-equivariant story, I will define $G$-equivariant formal group laws and give some examples.
Then I will discuss the dual of a $G$-equivariant formal group law, which is the structure possessed by the $E$-homology of $BU_G(1)$. 
The immersion of Big Data in all human experiences presents important challenges of managing, modeling, analyzing, interpreting, and visualizing complex information. There is a substantial need to develop, validate, productize, and support novel mathematical techniques, advanced statistical computing algorithms, transdisciplinary tools, and effective artificial intelligence apps.

Spacekime analytics is a new technique for modeling high-dimensional longitudinal data. This approach relies on extending the notions of time, events, particles, and wavefunctions to complex-time (kime), complex-events (kevents), data and inference-functions. We will illustrate how the kime-magnitude (longitudinal time order) and kime-direction (phase) affect the subsequent predictive analytics and the induced scientific inference. The mathematical foundation of spacekime calculus will reveal various statistical implications including inferential uncertainty and a Bayesian formulation of spacekime analytics. Complexifying time allows the lifting of all commonly observed processes from the classical 4D Minkowski spacetime to a 5D spacetime manifold, where a number of interesting mathematical problems arise.

Direct data science applications of spacekime analytics will be demonstrated using simulated data, clinical observations (e.g., UK Biobank), and environmental air quality data.

Joint work with Milen V. Velev (Burgas University, Bulgaria).

Combinatorics  
Friday, February 14, 2020, 3:00pm-4:00pm  
4096 East Hall  
David Speyer (University of Michigan)  
The degree of a Grothendieck polynomial

Grothendieck polynomials are polynomials in n variables, indexed by permutations of n elements. They encode the K-theory of the flag variety, and their lowest degree terms encode the cohomology of the flag variety. We study the highest degree part of Grothendieck polynomials, which should be related to the Castelnuovo-Mumford regularity of matrix Schubert varieties. We give a simple combinatorial rule for computing the degree of this highest degree part and show that, while there are n! many permutations, the number of highest degree parts (up to scalar multiple) is only the n-th Bell number. On the way, we discover surprising new properties of the classical major index statistic.

Joint work with Oliver Pechenik and Anna Weigandt.

Student Commutative Algebra  
Friday, February 14, 2020, 3:00pm-4:00pm  
3088 East Hall  
Michael Mueller (University of Michigan)  
The Quillen-Suslin Theorem

Projective modules in commutative algebra correspond to vector bundles in algebraic geometry. In 1955, Serre raised the question of whether every vector bundle on affine n-space A^n is trivial, or equivalently, whether every projective module over a polynomial ring k[x_1,...,x_n] is free. The Quillen-Suslin Theorem says that this is true, and we will present a proof due to Vaserstein.

Geometry  
Friday, February 14, 2020, 4:00pm-5:00pm  
3866 East Hall  
Lvzhou (Joe) Chen (UChicago)  
Big mapping class groups and rigidity of the simple circle

Surfaces of infinite type, such as the plane minus a Cantor set, occur naturally in dynamics. However, their mapping class groups are much less studied and understood compared to the mapping class groups of surfaces of finite type. Many fundamental questions remain open. We will discuss the mapping class group G of the plane minus a Cantor set, and show that any nontrivial G-action on the circle is semi-conjugate to its action on the so-called simple circle. Along the way, we will discuss some structural results of G to address the following questions: What are some interesting subgroups of G? Is G generated by torsion elements? This is joint work with Danny Calegari.