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<td>Ioannis Karatzas (Columbia University)</td>
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<td>Student Homotopy Theory</td>
<td>1372 East Hall</td>
<td>Montek Gill (University of Michigan)</td>
<td>An introduction to infinity-categories</td>
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<td>Jordan Keller (Harvard, Black Hole Initiative, Cambridge MA)</td>
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<td><strong>Applied Interdisciplinary Mathematics (AIM)</strong> -- Evgeniy Khain (Oakland University) <em>Levitating granular cluster: typical behavior and noise-induced rare events</em></td>
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<td><strong>Preprint Algebraic Geometry</strong> -- Devlin Mallory (UM) <em>Successive minima of line bundles, following Ambro and Ito</em></td>
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Abstracts for the week of September 22nd, 2019 - September 28th, 2019

Student Combinatorics
Monday, September 23, 2019, 3:00pm-4:00pm
3096 East Hall
Will Dana (UM)

Matroids II: Representability and the Curse of the Forbidden Minors

The two most important examples motivating the theory of matroids are edge sets of graphs and finite sets of vectors. However, as Alana showed us last week, the first example is actually a special case of the second. Does this mean that matroid theory is actually just linear algebra in disguise?

As this talk will explore, the answer is an emphatic no. Some matroids can't be represented by sets of vectors at all, while others can be, but only over particular ground fields. In this talk, we'll look at examples of these phenomena, and consider the tricky problem of characterizing when matroids are representable over certain fields. As time permits, we'll discuss an interesting fact: not only is matroid theory not linear algebra in disguise, but in a precise sense it never could have been, as shown in Vamos's delightfully titled paper "The Missing Axiom of Matroid Theory Is Lost Forever".

While it picks up where last week's talk left off, this talk should be accessible to anyone who knows what a matroid is.

Student Dynamics
Monday, September 23, 2019, 3:00pm-4:00pm
3866 East Hall
Mark Greenfield (UM)

A first look at the Mandelbrot set

One of the most well-studied parts of complex dynamics is the parameter space for quadratic polynomials. The Mandelbrot set is a subset of this parameter space corresponding to polynomials with certain nice dynamical properties. Despite a relatively straightforward definition, the Mandelbrot set exhibits astounding fractal-like properties, and a great deal of ingenuity has gone into understanding this set over the last few decades. In this talk, we will begin by introducing the Mandelbrot set and describing some of its fascinating characteristics. Then, we will prove a few of its basic topological properties, including giving an overview of J. Kahn's proof of connectedness.
Group, Lie and Number Theory  
**Monday, September 23, 2019, 4:00pm-5:00pm**  
4088 East Hall  
**Alexander Smith (Harvard University)**  
*NT RTG Lectures III: Sums of cocycles in collections of twists*

Given nonzero integers $d_1, d_2$ and an elliptic curve $E/Q$, the Galois module $E^{d_1d_2}[4]$ can be written as a subquotient of the Galois module $(E \oplus E^{d_1} \oplus E^{d_2})[4]$, where $E^d$ denotes $E$ twisted by the quadratic character associated to $\mathbb{Q}(\sqrt{d})$. This observation extends the fact that $E[2]$ is isomorphic to $E^{d_1}[2]$ and can be extended to 8-torsion, 16-torsion, etc. After applying this result to partially control the $2^k$-Selmer groups in some $k$-dimensional hypercubes of twists, we will show how the combinatorial trick from Talk II can be adapted to give the distribution of $2^k$-Selmer ranks in grids of twists.

Complex Analysis, Dynamics and Geometry  
**Monday, September 23, 2019, 4:00pm-5:00pm**  
3866 East Hall  
**Alex Kapiamba (U(M))**  
*The Yoccoz inequality and parabolic implosion*

The Yoccoz inequality provides a bound on the size of the limbs of the Mandelbrot set, however this bound is not sharp in most cases. Near parabolic parameters, for example the cusp of the main cardioid, the bound coming from the Yoccoz inequality appears to be far from optimal. Parabolic implosion, the theory of perturbations of parabolic functions, provides tools to understand the geometry of the Mandelbrot set near parabolic parameters. In this talk I will discuss the possibility of using parabolic implosion to improve the Yoccoz inequality near parabolic parameters.

Student Algebraic Geometry  
**Monday, September 23, 2019, 4:00pm-5:00pm**  
B745 East Hall  
**()**  
*Planning Meeting*

We'll plan the talks for the rest of the semester. Younger students are especially encouraged to attend; we'll try to schedule talks accessible to students currently in 631. Cookies will be served!
Student Analysis  
Monday, September 23, 2019, 5:00pm-6:00pm  
2866 East Hall  
Yuchen Liao (University of Michigan)  
*Traces and Fredholm determinants of Hilbert space operators*

It is a very natural question to generalize the concepts of trace and determinant of linear operators to infinite dimensional spaces. In this talk I will introduce the so-called trace class operators on complex separable Hilbert spaces for which the trace could be defined. We will also discuss a few basic properties of trace class operators and related concepts such as Hilbert-Schmidt operators. Time permitting I will also discuss the Fredholm determinants associate to trace class operators which is a natural generalization of usual determinants for operators on finite dimensional spaces.

Operators in Complex Analysis  
Monday, September 23, 2019, 5:00pm-6:00pm  
3096 East Hall  
Alex Izzo (Bowling Green State University)  
*Gleason parts in hulls with no analytic discs*

It was once conjectured that whenever a compact set in complex Euclidean space has a nontrivial polynomial hull, there must be an analytic disc in the hull. This conjecture was disproved by Stolzenberg in 1963. Nevertheless, attempts to prove the conjecture led to much interesting mathematics. In particular, Gleason's introduction of his parts was motivated by the conjecture. Garnett proved in 1967 that in no reasonable sense can Gleason parts be regarded as analytic sets in general. However, the uniform algebras constructed by Garnett do have a great deal of analytic structure. I will present recent joint work with Papathanasiou that strengthens Garnett's result by obtaining the Gleason parts in the complete absence of analytic discs.

Group, Lie and Number Theory  
Tuesday, September 24, 2019, 3:00pm-4:00pm  
4088 East Hall  
Alexander Smith (Harvard University)  
*NT RTG Lectures IV*
I will introduce the notion of a configuration space, and present several fundamental theorems regarding the fundamental groups of configuration spaces. Special attention will be paid to the configuration space of a set of n marked points on the plane, and braid groups. If time permits, I will present some results on the stability of the cohomology of these spaces as representations of symmetric groups.

We introduce models for financial markets and, in their context, the notions of portfolio rules and of arbitrage. The absence of arbitrage is a central requirement in the modern theories of mathematical economics and finance, as is the even stronger notion of equivalent martingale measure. We relate this to probabilistic concepts such as fair game, martingales, and coherence in the sense of de Finetti.

We also survey a newer, descriptive approach to finance, based on the existence of a growth-optimal portfolio (equivalently, of a portfolio with the so-called "numeraire" property). These equivalent notions proscribe only egregious forms of arbitrage, and lead to an entire theory for the subject which is flexible and simple, allows the outperformance of one portfolio by another, and is able to deal with an arbitrary number of assets. This part of the talk is based on a book in preparation, with Constantinos Kardaras.

I will give an introduction to the basics of infinity-categories (aka quasicategories). Some examples will be included. Relations to some related concepts, such as topologically enriched categories and model categories, will also be mentioned.
Student Arithmetic
Wednesday, September 25, 2019, 3:00pm-4:00pm
3866 East Hall
Ilia Nekrasov (UM)
Coleman Integration

R. Coleman has introduced a notion of p-adic integration in 1982. For algebraic curves, Coleman integration is an explicit way to integrate forms over paths joining two p-adic points. In this talk, I will introduce this notion, show a couple examples, and present several (old and not so old) applications.

Financial/Actuarial Mathematics
Wednesday, September 25, 2019, 4:00pm-5:00pm
1360 East Hall
Ioannis Karatzas (Columbia University)
Van Eenam Lecture #2: Conservative Diffusion as Entropic Gradient Flow

We provide a detailed probabilistic interpretation, based on stochastic calculus, for the variational characterization of conservative diffusion as entropic gradient flux. Jordan, Kinderlehrer, and Otto showed in 1998 that, for diffusions of Langevin-Smoluchowski type, the Fokker-Planck probability density flow minimizes the rate of relative entropy dissipation, as measured by the distance traveled in terms of the quadratic Wasserstein metric in the ambient space of configurations. Using a very direct perturbation analysis we obtain novel, stochastic-process versions of such features. These are valid along almost every trajectory of the diffusive motion, in both the forward and, most transparently, the backward, directions of time. The original results follow then simply by taking expectations. As a bonus of the approach we obtain the HWI inequality of Otto and Villani relating relative entropy, Fisher information, and Wasserstein distance; and from it the celebrated log-Sobolev, Talagrand and Poincare inequalities of functional analysis. (Joint work with W. Schachermayer and B. Tschiderer.)

Algebraic Geometry
Wednesday, September 25, 2019, 4:00pm-5:30pm
4096 East Hall
Shizhang Li (UM)
On rigid varieties with projective reduction

We will first give a low-tech introduction to rigid varieties and their formal models. Then we will state and discuss the main theorem which concerns the Picard variety of a smooth proper rigid variety.
RTG Seminar on Geometry, Dynamics and Topology  
Wednesday, September 25, 2019, 4:00pm-5:30pm  
3866 East Hall  
Salman Siddiqi (U Michigan)  
*Correlation decay for some isometric extensions of Anosov flows*

I will briefly provide some historical context discussing known results on exponential correlation decay (or exponential mixing) for Anosov flows, after which I will give criteria for obtaining exponential mixing for certain isometric extensions of these flows. I'll sketch a proof that locally accessible isometric extensions of Anosov flows are exponentially mixing under certain conditions - this includes, for example, certain classes of frame flows and flows on principle bundles.

Commutative Algebra  
Thursday, September 26, 2019, 3:00pm-4:00pm  
4088 East Hall  
Mel Hochster (University of Michigan)  
*An Overview of Tight Closure Theory I*

This is the first of two talks. Tight closure will be defined both for Noetherian rings of characteristic $p > 0$ and equal characteristic 0. A number of characterizations will be given, along with a discussion of some basic properties. The theory will be applied to give easy proofs of some substantial theorems. A number of open questions will be discussed.

Financial/Actuarial Mathematics  
Thursday, September 26, 2019, 4:00pm-5:00pm  
1360 East Hall  
Ioannis Karatzas (Columbia University)  
*Van Eenam Lecture #3: The Harrison-Shepp Equation and some of Its Offspring*

In a pioneering article from 1981, Harrison and Shepp provided a stochastic integral equation characterizing the skew Brownian motion of Ito & McKean (1963). We provide similar characterizations for skew-reflected scalar semimartingales, and for a class of planar processes with a roundhouse singularity at the origin which we call "Walsh semimartingales" and which include the Walsh Brownian motion as a special case. Armed with this description, and with an associated stochastic calculus that we develop, we formulate and solve problems of optimal control with discretionary stopping for such Walsh semimartingales. (Joint work with Tomoyuki Ichiba, Vilmos Prokaj and Minghan Yan.)
We calculate the limits of the quasi-local angular momentum and center-of-mass defined by Chen-Wang-Yau for a family of spacelike two-spheres approaching future null infinity in an asymptotically flat spacetime admitting a Bondi-Sachs expansion. Our result complements earlier work of Chen-Wang-Yau, where the authors calculate the quasi-local energy and linear momentum at null infinity. Working in the center-of-mass frame, i.e. assuming vanishing of linear momentum at null infinity, we obtain explicit expressions for the angular momentum and center-of-mass at future null infinity in terms of the observables appearing in the Bondi-Sachs expansion of the spacetime metric. This is joint work with Ye-Kai Wang and Shing-Tung Yau.

Arithmetic Geometry Learning
Thursday, September 26, 2019, 4:00pm-5:30pm
4096 East Hall
Zili Zhang (UM)
Cohomology
Granular matter is ubiquitous in nature and exhibits a variety of nontrivial phenomena. In addition, granular medium is intrinsically far from equilibrium, as particles collide inelastically, and a continuous energy input is required to ensure a steady state. Within the same system, different regions of granular media can be at a solid or a gas phase. Here we focus on a granular Leidenfrost effect: a solid-like cluster is levitating above the "hot" granular gas [1]. This state was observed experimentally, when granular matter was vertically vibrated in a two-dimensional container [2]. The solid-gas coexistence can be described by using granular hydrodynamics with the properly measured transport coefficients [3]. We performed extensive molecular dynamics simulations of a simple model of inelastic hard spheres driven by a "thermal" bottom wall. Simulations showed that for low wall temperatures, the levitating cluster is stable, while for high wall temperatures, it breaks down, and the hot gas bursts out resembling a volcanic explosion [4]. We found a hysteresis: for a wide range of bottom wall temperatures, both the clustering state and the broken state are stable. However, even if the system is at the (stable) clustering state, a "volcanic explosion" is possible: it is a rare event driven by large fluctuations. We used techniques from the theory of rare events to compute the mean time for cluster breaking to occur; this required the introduction of a two-component reaction coordinate [4].

Combinatorics
Friday, September 27, 2019, 3:00pm-4:00pm
4096 East Hall
Hanbaek Lyu (UCLA)
Phase transition in random contingency tables with non-uniform margins

For parameters $n, \delta, B,$ and $C$, let $X=(X_{k\ell})$ be the random uniform contingency table whose first $n^\delta$ rows and columns have margin $BCn$ and the last $n$ rows and columns have margin $Cn$. For every $0<\delta<1$, we establish a sharp phase transition of the limiting distribution of each entry of $X$ at the critical value $B_c=1+\sqrt{1+1/C}$. In particular, for $1/2<\delta<1$, we show that the distribution of each entry converges to a geometric distribution in total variation distance, whose mean depends sensitively on whether $B<B_c$ or $B>B_c$. Our main result shows that $\E[X_{11}]$ is uniformly bounded for $B<B_c$, but has sharp asymptotic $C(B-B_c)n^{1-\delta}$ for $B>B_c$. We also establish a strong law of large numbers for the row sums in top right and top left blocks.

This is a joint work with Sam Dittmer and Igor Pak.

Geometry
Friday, September 27, 2019, 4:00pm-5:00pm
3866 East Hall
Alastair Fletcher (Northern Illinois University)
Generalized Derivatives

Quasiregular mappings are only differentiable almost everywhere. There is, however, a satisfactory replacement for the derivative at points of nondifferentiability. These are generalized derivatives and were introduced by Gutlyanskii et al in 2000. In this talk, we discuss some recent results on generalized derivatives, in particular the question of how many generalized derivatives there can be at a particular point, and explain how versions of the Chain Rule and Inverse Function Formula hold in this setting. We also give some applications to Schroeder functional equations.
Junior Colloquium Series  
Friday, September 27, 2019, 4:00pm-6:00pm  
3088 East Hall  
Samuel Hansen (U Michigan Math Library)  
*Introduction to the Library or how your librarian can make your research easier and better and more fun*

Introduction to the Library or how your librarian can make your research easier and better and more fun

As students at the University of Michigan you have access to an amazing amount of resources through the University of Michigan library, so many that you likely do not know 10% of what is available. In their talk Samuel Hansen, the Mathematics & Statistics librarian, will highlight the most important mathematics resources available from the library, show how to use them effectively, discuss how the library can help make your path to finish your degree smoother, and even toss in some information about how to manage all those citations.

Preprint Algebraic Geometry  
Friday, September 27, 2019, 4:00pm-5:30pm  
4096 East Hall  
Devlin Mallory (UM)  
*Successive minima of line bundles, following Ambro and Ito*

http://front.math.ucdavis.edu/1901.09341