### Monday, January 13, 2020

<table>
<thead>
<tr>
<th>Time</th>
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<tbody>
<tr>
<td>3:00pm-4:00pm</td>
<td><strong>Student Combinatorics</strong> -- ()</td>
<td>Student Combinatorics Planning Meeting -- 3088 East Hall</td>
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<tr>
<td>3:00pm-3:50pm</td>
<td><strong>Student Dynamics</strong> -- () Planning Meeting -- 3866 East Hall</td>
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<tr>
<td>4:10pm-5:00pm</td>
<td><strong>Group, Lie and Number Theory</strong> -- Vishal Arul (MIT) Torsion points on curves of the form $y^n = x^d + 1$ -- 4096 East Hall</td>
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<td>5:00pm-5:30pm</td>
<td><strong>Student Analysis</strong> -- () Planning Meeting -- 4088 East Hall</td>
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### Tuesday, January 14, 2020

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<tr>
<td>4:00pm-5:00pm</td>
<td><strong>Colloquium Series</strong> -- Zaher Hani (University of Michigan) On the rigorous derivation of the wave kinetic equation -- 1360 East Hall</td>
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### Wednesday, January 15, 2020

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<td><strong>Financial/Actuarial Mathematics</strong> -- Gabriel Khan (UM) The Regularity of Pseudo-Arbitrages: PROBLEMS -- 1360 East Hall</td>
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<tr>
<td>4:00pm-5:20pm</td>
<td><strong>Algebraic Geometry</strong> -- Moises Herradon Cueto (LSU) The local type of difference equations -- 4096 East Hall</td>
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### Thursday, January 16, 2020

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<td><strong>Differential Equations</strong> -- Jiajie Chen (Cal Tech) Singularity formation for 2D Boussinesq and 3D Euler equations with boundary and some related 1D models -- 4088 East Hall</td>
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<td>4:00pm-5:00pm</td>
<td><strong>Group, Lie and Number Theory</strong> -- Atticus Christensen (MIT) Specialization of Neron-Severi groups in characteristic $p&gt;0$ -- 2866 East Hall</td>
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### Friday, January 17, 2020

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<td>3:00pm-4:00pm</td>
<td><strong>Student Commutative Algebra</strong> -- Eamon Quinlan-Gallego (University of Michigan Ann Arbor) D-modules in characteristic p and test ideals -- 3088 East Hall</td>
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<tr>
<td>4:00pm-6:00pm</td>
<td><strong>Junior Colloquium Series</strong> -- Alexander Barvinok (Michigan) The mathematics of computational complexity (Research at Michigan Series) -- 3088 East Hall</td>
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<td>4:00pm-5:30pm</td>
<td><strong>Preprint Algebraic Geometry</strong> -- Brian Lawrence (Chicago) See NSF-RTG lecture series talk I in GLNT seminar -- 4096 East Hall</td>
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<td>4:00pm-5:00pm</td>
<td><strong>Group, Lie and Number Theory</strong> -- Brian Lawrence (University of Chicago) NT RTG Lectures I: Diophantine problems and a p-adic period map -- 4096 East Hall</td>
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Student Combinatorics
Monday, January 13, 2020, 3:00pm-4:00pm
3088 East Hall

Student Combinatorics Planning Meeting

Come help brainstorm topics and sign up for talks for the Student Combinatorics Seminar this semester! There will be snacks too!

Student Dynamics
Monday, January 13, 2020, 3:00pm-3:50pm
3866 East Hall

Planning Meeting

Group, Lie and Number Theory
Monday, January 13, 2020, 4:10pm-5:00pm
4096 East Hall
Vishal Arul (MIT)

Torsion points on curves of the form \( y^n = x^d + 1 \)

The goal of this talk is to classify torsion points on the curve \( y^n = x^d + 1 \) over the complex numbers, where \( n, d \) are at least 2 and are coprime. We will motivate the central ideas of the proof by studying the proof of the result by Poonen and Stoll that the only torsion points on a generic hyperelliptic curve are the 2-torsion Weierstrass points. For our case, we will replace the “big geometric monodromy” of their argument with “big Galois action on the torsion of the Jacobian.” As a corollary, we will extend the Poonen-Stoll result to superelliptic curves. If time permits, we will explain connections with Jacobi sums, cyclotomic units, Vandiver’s conjecture, and Anderson-Ihara theory.
Student Analysis
Monday, January 13, 2020, 5:00pm-5:30pm
4088 East Hall

Planning Meeting

Student Analysis Seminar will kick off the semester with a planning meeting to create a schedule of talks for the semester. If you have not attended Student Analysis Seminar before, today is a great day to get involved!

We define "analysis" very broadly and welcome anyone with an interest in analysis-related topics. Last semester's topics included operator theory, probability, complex analysis, and more. We look forward to hearing all of your ideas for this semester.

First year grad students are especially encouraged to attend! As always, there will be snacks and other cool grad students who are interested in analysis. We hope to see you there!

Colloquium Series
Tuesday, January 14, 2020, 4:00pm-5:00pm
1360 East Hall
Zaher Hani (University of Michigan)

On the rigorous derivation of the wave kinetic equation

A fundamental question in the theory of statistical mechanics of nonlinear waves (often called "wave turbulence theory"), is the rigorous justification of the so-called Wave Kinetic Equation (WKE) starting from Hamiltonian first principles (usually given by a nonlinear dispersive or hyperbolic PDE). This is a monumental mathematical problem featuring aspects from PDE analysis, probability, combinatorics, and even analytic number theory. We will discuss some recent advances on this problem, focusing on a recent joint work with Yu Deng (USC).

Student Arithmetic
Wednesday, January 15, 2020, 3:00pm-4:00pm
3088 East Hall

Planning meeting

We will be scheduling the talks for the semester. Please come and let us know what you'd like to hear/speak about!
Financial/Actuarial Mathematics  
Wednesday, January 15, 2020, 4:00pm-5:00pm  
1360 East Hall  
Gabriel Khan (UM)  
The Regularity of Pseudo-Arbitrages: PROBLEMS

Given an equity market with n stocks, a pseudo-arbitrage is an investment strategy (i.e. a portfolio map) which outperforms the market portfolio (i.e. the buy-and-hold option) almost surely in the long run. When the market weights evolve via some unknown discrete time process, Fernholz proved that such portfolio maps exist, under mild and realistic assumptions. Recently, Pal and Wong showed that the problem of finding pseudo-arbitrages is equivalent to solving a certain Monge-Kantorovich optimal transport problem where the cost function is given by the so-called "diversification return," which is closely related to the free energy in statistical physics. In our work, we study the regularity theory for these maps. In other words, we consider the question "If the market conditions change slightly, does the investment portfolio also change in a continuous way?" By addressing this problem, an unexpected connection to Kähler geometry emerges. This provides a new geometric interpretation for the regularity theory of optimal transport.
Algebraic Geometry
Wednesday, January 15, 2020, 4:00pm-5:20pm
4096 East Hall
Moises Herradon Cueto (LSU)
The local type of difference equations

D-modules allow us to study differential equations through the lens of algebraic geometry. They are widely studied and have been shown to be full of structure. In contrast, the case of difference equations is lacking some of the most basic constructions. We focus on the following question: D-modules have a clear notion of what it means to restrict to a (formal) neighborhood of a point, namely extension of scalars to a power series ring. However, what does it mean to restrict a difference equation to a neighborhood of a point? I will give an answer which encompasses the intuitive notions of a "zero" and a "pole" of a difference equation, but further it is consistent in two more ways. First of all, we can show that restricting a difference equation to a point and to its complement is enough to recover the difference equation. Secondly, there exists a local Mellin transform analogous to the local Fourier transform. The local Fourier transform describes singularities of a D-module on the affine line in terms of the singularities of its Fourier transform. Similarly, the Mellin transform is an equivalence between D-modules on the punctured affine line and difference modules on the line, and we can relate singularities on both sides via this local Mellin transform. I will also talk about how to apply the same ideas to other kinds of difference equations, such as elliptic equations, which generalize difference and differential equations at once.

Differential Equations
Thursday, January 16, 2020, 4:00pm-5:00pm
4088 East Hall
Jiajie Chen (Cal Tech)
Singularity formation for 2D Boussinesq and 3D Euler equations with boundary and some related 1D models

In this talk, we will discuss recent results on stable self-similar singularity formation for the 2D Boussinesq and singularity formation for the 3D Euler equations in the presence of the boundary with $C^{1,\alpha}$ initial data for the velocity field that has finite energy. The blowup mechanism is based on the Hou-Luo scenario of a potential 3D Euler singularity. We will also discuss briefly some 1D models for the 3D Euler equations that develop stable self-similar singularity in finite time. For these models, the regularity of the initial data can be improved to $C_c^\infty$. Some of the results are joint work with Thomas Hou and De Huang.
Group, Lie and Number Theory  
Thursday, January 16, 2020, 4:00pm-5:00pm  
2866 East Hall  
Atticus Christensen (MIT)  
Specialization of Neron-Severi groups in characteristic $p>0$

We will present two results on the specialization of Neron-Severi groups in characteristic $p>0$. The first bounds the exponent of $p$ which kills the cokernels of specializations of Neron-Severi groups coming from any family of algebraic varieties. The second result is analogous to a result of Andre and of Maulik and Poonen in mixed characteristic and establishes that given a smooth projective family of algebraic varieties over an algebraically closed field $K$ of characteristic $p>0$ not isomorphic to $\bar{F}_p$, there exists a $K$ point outside of the Noether-Lefschetz locus. We will explain how Morrow’s Lefschetz $(1,1)$ for crystalline cohomology is used to prove the first result and how the second result follows from the first.

Combinatorics  
Friday, January 17, 2020, 3:00pm-4:00pm  
4096 East Hall  
Michael Shapiro (Michigan State U.)  
Generalized cluster structures in the space of periodic staircase matrices

It is well known that cluster relations in $\text{GL}_n$ are often modeled on determinantal identities, such as short Plucker relations, Desnanot-Jacobi identities and their generalizations. We present a similar construction of determinantal identities in the space of periodic infinite matrices of special (staircase) form and discuss its application to generalized cluster structures in $\text{GL}_n$ compatible with a certain subclass of Belavin-Drinfeld Poisson-Lie brackets, in the Drinfeld double of $\text{GL}_n$, and in the space of periodic difference operators. This is a joint work with M.Gekhtman and A.Vainshtein.

Applied Interdisciplinary Mathematics (AIM)  
Friday, January 17, 2020, 3:00pm-4:00pm  
1084 East Hall  
Silas Alben (University of Michigan)  
Optimizing snake locomotion

Snakes propel themselves by a variety of gaits such as slithering and sidewinding. We use a model to determine which planar snake motions are optimal for efficiency. With large friction transverse to the snake, the optimal motion is a retrograde traveling wave with amplitude scaling as the friction coefficient the $-1/4$ power. With zero transverse friction, a triangular direct wave is optimal. Between these extremes we find a variety of local optima including standing waves (or ratcheting motions).
Student Commutative Algebra  
Friday, January 17, 2020, 3:00pm-4:00pm  
3088 East Hall  
Eamon Quinlan-Gallego (University of Michigan Ann Arbor)  
*D-modules in characteristic p and test ideals*

We will define differential operators in characteristic p and use them to show that jumping numbers of test ideals form a discrete and rational set (following Blickle, Mustață, and Smith).

Junior Colloquium Series  
Friday, January 17, 2020, 4:00pm-6:00pm  
3088 East Hall  
Alexander Barvinok (Michigan)  
*The mathematics of computational complexity (Research at Michigan Series)*

Why it appears to be much harder to compute the permanent than the determinant of a (complex) matrix? Essentially, this is one of the seven “million dollars” millennium problems, and, arguably, the one that we understand the least. I plan to discuss what kind of mathematics we can possibly use to answer this and similar questions. An attractive feature of the computational complexity questions is that a) they sound elementary and b) virtually anything (algebra, geometry/topology, analysis, none of the above) can be a key to the answer. In particular, I plan to discuss some recent connections to complex analysis and statistical physics.

Preprint Algebraic Geometry  
Friday, January 17, 2020, 4:00pm-5:30pm  
4096 East Hall  
Brian Lawrence (Chicago)  
See NSF-RTG lecture series talk I in GLNT seminar
One can study the variation of p-adic Galois representations in families using p-adic Hodge theory and a p-adic period map. This leads to several arithmetic applications: Mordell's conjecture, a weak Shafarevich conjecture for hypersurfaces in projective space, and the full Shafarevich conjecture for hypersurfaces in certain abelian varieties.

In the first talk, I'll explain the p-adic period map and the application to Mordell. In the second and third talks, I'll discuss further ideas that are needed for the other two results. Talks 2 and 3 will be completely independent of each other, and largely independent of the first.

(The first talk is on joint work with Akshay Venkatesh; the third, joint work with Will Sawin.)