### Monday, March 14, 2016

<table>
<thead>
<tr>
<th>Time</th>
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<th>Details</th>
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<tbody>
<tr>
<td>12:00pm-1:00pm</td>
<td><strong>Mathematical Biology</strong> -- Jeff Hasty (University of California San Diego) Engineered Genetic Clocks: From degrade and fire to integrate and fire dynamics</td>
<td>-- 335 West Hall</td>
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<tr>
<td>1:00pm-2:00pm</td>
<td><strong>Student Arithmetic</strong> -- Brandon Carter () TBA</td>
<td>-- 1866 East Hall</td>
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<tr>
<td>3:00pm-4:00pm</td>
<td><strong>Borcherds Products Learning Seminar</strong> -- Charlotte Chan () Borcherds products</td>
<td>-- 4088 East Hall</td>
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<tr>
<td>4:00pm-5:00pm</td>
<td><strong>Complex Analysis, Dynamics and Geometry</strong> -- Michael Kelly (U(M)) BD Equivalence for Return times of Linear Flows on the Torus</td>
<td>-- 3096 East Hall</td>
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<tr>
<td>4:10pm-5:30pm</td>
<td><strong>Group, Lie and Number Theory</strong> -- Ari Shnidman (Boston College) Cubic twist families of elliptic curves and parameterizing cubic fields</td>
<td>-- 4088 East Hall</td>
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### Tuesday, March 15, 2016

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<tr>
<td>3:00pm-4:00pm</td>
<td><strong>Student Geometry/Topology</strong> -- Feng Zhu (UM) Towards the Virtually Haken theorem</td>
<td>-- 1866 East Hall</td>
</tr>
<tr>
<td>4:10pm-5:00pm</td>
<td><strong>Colloquium Series</strong> -- Percy Deift (Courant Institute, NYU) Ziwet lecture I: Universality in numerical computations with random data. Case studies</td>
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### Wednesday, March 16, 2016

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<tr>
<td>3:00pm-4:00pm</td>
<td><strong>Financial/Actuarial Mathematics</strong> -- Jinniao Qiu (UM) Weak Solution for Fully Nonlinear Stochastic Hamilton-Jacobi-Bellman Equations and its Applications</td>
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<td>3:00pm-4:00pm</td>
<td><strong>SPECIAL EVENT</strong> -- Tim Ferguson (University of Alabama) Extremal Problems for Analytic Functions and Their Connections to Other Topics</td>
<td>-- 4096 East Hall</td>
</tr>
<tr>
<td>4:00pm-5:00pm</td>
<td><strong>Financial/Actuarial Mathematics</strong> -- Matin Herdegen (ETH) Sensitivity of Optimal Consumption Streams</td>
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<td><strong>Analysis/Probability</strong> -- Percy Deift (Courant Institute, NYU) Ziwet Lecture 2: Riemann-Hilbert problems</td>
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<td>3:00pm-4:00pm</td>
<td><strong>Topology</strong> -- Viveka Erlandsson (University of Fribourg) Counting curves on hyperbolic surfaces</td>
<td>-- 1866 East Hall</td>
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<tr>
<td>4:00pm-5:00pm</td>
<td><strong>Math Club</strong> -- Malke Rosenfeld (Math Educator/ Percussive Dance Teaching Artist) Math in Unexpected Spaces</td>
<td>-- Nesbitt Room</td>
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<td><strong>Differential Equations</strong> -- Percy Deift (Courant Institute, NYU) Ziwet Lecture 3: The Toda eigenvalue algorithm: Universality of fluctuations of halting times</td>
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<td><strong>Student Algebraic Geometry</strong> -- Takumi Murayama (University of Michigan) TBA</td>
<td>-- 4096 East Hall</td>
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<tr>
<td>10:30am-11:30am</td>
<td><strong>Theoretical Computer Science</strong> -- Sina Shiehian (U-M) <em>Multi-Key FHE from LWE, Revisited</em> -- 3725 BBB</td>
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<td><strong>Borcherds Products Learning Seminar</strong> -- Andrew Snowden () <em>Heegner divisors and Borcherds products</em> -- 1096 East Hall</td>
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<td>3:00pm-4:00pm</td>
<td><strong>Applied Interdisciplinary Mathematics</strong> -- Ihsan Topaloglu (McMaster University) <em>Nonlocal energies defined via attractive-repulsive interaction potentials</em> -- 1084 East Hall</td>
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<td><strong>Combinatorics</strong> -- Mihai Ciucu (U. Indiana) <em>Lozenge tilings with gaps in a 90 degree wedge domain with mixed boundary conditions</em> -- 4088 East Hall</td>
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<td><strong>Geometry</strong> -- Dylan Thurston (Indiana University) <em>Energies for maps between graphs</em> -- 3096 East Hall</td>
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<td>4:10pm-5:30pm</td>
<td><strong>Preprint Algebraic Geometry Seminar</strong> -- Matt Stevenson (UM) <em>The gonality conjecture on syzygies of algebraic curves of large degree (following Ein and Lazarsfeld)</em> -- 2866 East Hall</td>
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Mathematical Biology
Monday, March 14, 2016, 12:00pm-1:00pm
335 West Hall
Jeff Hasty (University of California San Diego)

Engineered Genetic Clocks: From “degrade and fire” to “integrate and fire” dynamics

A defining component of Synthetic Biology is the development of theoretical modeling that can serve as the foundation for a new type of cellular engineering. This talk will be anchored by my quest to build genetic oscillators in bacteria, with a particular focus on the utility of theory and computation. I'll start by describing how the coupling of transcriptional activators and repressors was originally modeled as a type of classical "predator-prey" system. Although this system led to the design of a robust intracellular clock (http://biodynamics.ucsd.edu/Intracellular.mov), I'll show how the experiments pointed to a different type of "degrade and fire" oscillator characterized by a coupled set of delayed differential equations. Interestingly, the biological constraints naturally lead to a system that can be solved approximately.

In terms of engineering, the clock was not of the Swiss variety; the period and amplitude exhibited large intracellular variability. However, it provided a benchmark for the development of general synchronization strategies that can restore determinism. I'll conclude with our efforts to use cellular communication to couple clocks between cells (http://biodynamics.ucsd.edu/Intercellular.mov) and colonies (http://biodynamics.ucsd.edu/Intercolony.mov). Here, the threshold nature of the communication mechanism leads naturally to oscillators that are highly reminiscent of "integrate and fire" systems in neuroscience.

Student Arithmetic
Monday, March 14, 2016, 1:00pm-2:00pm
1866 East Hall
Brandon Carter ()
TBA

Borcherds Products Learning Seminar
Monday, March 14, 2016, 3:00pm-4:00pm
4088 East Hall
Charlotte Chan ()
Borcherds products
Linear flows on the torus are some of the simplest dynamical systems yet there are many basic questions about them that remain unanswered. For instance, a large class of mathematical quasicrystals called cut-and-project sets can be realized as return times of linear toral flows to a section-- and there are many basic unanswered questions in the active field of mathematical quasicrystals! For instance, it is a fundamental question whether a quasicrystal can be obtained as a bounded perturbation of a crystal, or rather if return times of a linear toral flow set can be realized as a bounded perturbation of a lattice. We will show that for almost every linear toral flow the answer is yes, but there is a topologically residual set of linear toral flows for which the answer is no. This is joint work with Alan Haynes, Henna Koivusalo, Lorenzo Sadun, and Barak Weiss.

We give estimates for the average size of the 3-Selmer group in cubic twist families of elliptic curves, and show that for all but one of these families, the average size of 3-Selmer is infinite. We also show that 0% of curves in a given cubic twist family of genus 1 curves are everywhere locally soluble. Along the way, we give a new parameterization of cubic fields in terms of "cube roots" in the class groups of quadratic fields. This is joint work with Manjul Bhargava.

In 2012, Ian Agol filled in the last gap remaining in a proof of the Virtually Haken conjecture. Agol's result answers many questions about the structure of hyperbolic 3-manifolds, and also opens new avenues for exploration. We will give a sketch of the proof of the Virtually Haken conjecture that Agol caps off. The emphasis will be on the overall structure of the argument, and on the motivation for and general idea behind the use of tools that range from ergodic theory to geometric group theory.
Colloquium Series  
Tuesday, March 15, 2016, 4:10pm-5:00pm  
1360 East Hall  
Percy Deift (Courant Institute, NYU)  

Ziwwet lecture I: Universality in numerical computations with random data. Case studies

This is joint work with Govind Menon, Sheehan Olver and Thomas Trogdon. The speaker will present evidence for universality in numerical computations with random data. Given a (possibly stochastic) numerical algorithm with random input data, the time (or number of iterations) to convergence (within a given tolerance) is a random variable, called the halting time. Two-component universality is observed for the fluctuations of the halting time, i.e., the histogram for the halting times, centered by the sample average and scaled by the sample variance, collapses to a universal curve, independent of the input data distribution, as the dimension increases. Thus, up to two components, the sample average and the sample variance, the statistics for the halting time are universally prescribed. The case studies include six standard numerical algorithms, as well as a model of neural computation and decision making.

Financial/Actuarial Mathematics  
Wednesday, March 16, 2016, 3:00pm-4:00pm  
3088 East Hall  
Jinniao Qiu (UM)  

Weak Solution for Fully Nonlinear Stochastic Hamilton-Jacobi-Bellman Equations and its Applications

This talk is concerned with the stochastic Hamilton-Jacobi-Bellman (HJB) equation with controlled leading coefficients, which is a type of fully nonlinear stochastic partial differential equation (SPDE). In order to formulate the weak solution for such kind of SPDEs, a class of regular random parabolic potentials are introduced in the stochastic framework. The existence and uniqueness of weak solution is proved, which seems new even for the classical HJB equations. For the partially non-Markovian case, we obtain the associated gradient estimate. The applications in finance and economics will be discussed as well if time allows.

SPECIAL EVENT  
Wednesday, March 16, 2016, 3:00pm-4:00pm  
4096 East Hall  
Tim Ferguson (University of Alabama)  

Extremal Problems for Analytic Functions and Their Connections to Other Topics

In this talk, I will discuss extremal problems in spaces of analytic functions and connections between such problems and other areas of analysis. The main focus will be the problem of maximizing linear functionals on Bergman spaces, which are spaces of analytic functions of finite $L^p$ norm. I will speak about the connections of this problem to topics in analysis such as partial differential equations, quasiconformal mappings, and uniform convexity.
Financial/Actuarial Mathematics
Wednesday, March 16, 2016, 4:00pm-5:00pm
1360 East Hall
Matin Herdegen (ETH)
Sensitivity of Optimal Consumption Streams

We study the sensitivity of optimal consumption streams with respect to perturbations of the random endowment. At the leading order, the consumption adjustment does not matter: any choice that matches the budget constraint simply shifts the original utility by the marginal value of the perturbation. Nontrivial results obtain at the next-to-leading order. Here, one first solves the problem for a deterministic perturbation, which leads to a â€œprognosis measureâ€. The desired consumption adjustment for a general endowment perturbation is in turn given by the conditional expectation of the latter, computed under this measure and appropriately weighted with the conditional expectations of the remaining risk-tolerance. As an interesting application, we consider the problem of optimal consumption with small transaction costs.

The talk is based on joint work with Johannes Muhle-Karbe (University of Michigan).

Analysis/Probability
Wednesday, March 16, 2016, 4:10pm-5:00pm
2866 East Hall
Percy Deift (Courant Institute, NYU)
Zwet Lecture 2: Riemann-Hilbert problems

The great utility of special functions, such as Bessel functions, Legendre functions, hypergeometric functions etc., rests in large part on the fact that the asymptotic behavior of these functions as some associated parameter becomes large can be described with great accuracy. This is possible because these functions all have integral representations from which the asymptotics can be deduced in turn using, for example, the classical steepest-descent/stationary phase method. The Riemann-Hilbert problem provides a nonlinear, non-commutative generalization of integral representations, which makes possible the detailed analysis, particularly the asymptotic analysis, of a wide variety of nonlinear problems such as KdV, NLS etc., and also problems in areas such as orthogonal polynomials and random matrix theory: Here a nonlinear/ non-commutative version of the steepest-descent method plays a key role. The speaker will discuss developments in Riemann-Hilbert theory that have taken place in recent years.
In this talk I will discuss the growth of the number of closed geodesic of bounded length, and the length grows. More precisely, let \( c \) be a closed curve on a hyperbolic surface \( S = S(g,n) \) and let \( N_c(L) \) denote the number of curves in the mapping class orbit of \( c \) with length bounded by \( L \). Due to Mirzikhani it is know that in the case that \( c \) is simple this number is asymptotic to \( L^{6g-6+2n} \). Here we consider the case when \( c \) is an arbitrary closed curve, i.e. not necessarily simple. This is joint work with Juan Souto.

**Math Club**  
**Thursday, March 17, 2016, 4:00pm-5:00pm**  
**Nesbitt Room**  
**Malke Rosenfeld (Math Educator/ Percussive Dance Teaching Artist)**  
*Math in Unexpected Spaces*

Experience math as both an art and a science using just a little bit of tape and your own two feet. Harness the math of making and making comparisons to explore congruence, symmetry, transformations, categorical variables, group theory, and spatially complex physical/temporal patterns. Future math teachers welcome.

**Differential Equations**  
**Thursday, March 17, 2016, 4:00pm-5:00pm**  
**4088 East Hall**  
**Percy Deift (Courant Institute, NYU)**  
*Ziwet Lecture 3: The Toda eigenvalue algorithm: Universality of fluctuations of halting times*

This is joint work with Tom Trogdon. The speaker will show how to prove rigorously universality of the fluctuations in the halting times described in Talk 1, in the particular case of the Toda eigenvalue algorithm.

**Student Algebraic Geometry**  
**Thursday, March 17, 2016, 4:00pm-5:00pm**  
**4096 East Hall**  
**Takumi Murayama (University of Michigan)**  
*TBA*
Theoretical Computer Science
Friday, March 18, 2016, 10:30am-11:30am
3725 BBB
Sina Shiehian (U-M)
Multi-Key FHE from LWE, Revisited

Traditional fully homomorphic encryption (FHE) schemes only allow computation on data encrypted under a single key. Lopez-Alt, Tromer, and Vaikuntanathan (STOC 2012) proposed the notion of a multi-key FHE, which allows homomorphic computation on ciphertexts encrypted under different keys, and also gave a construction based on a (somewhat nonstandard) assumption related to NTRU. More recently, Clear and McGoldrick (CRYPTO 2015), followed by Mukherjee and Wichs (EUROCRYPT 2016), proposed a multi-key FHE based on learning with errors (LWE). However, unlike the original construction of Lopez-Alt et al., these later LWE-based schemes have the somewhat undesirable property of being "single-hop" with respect to keys, i.e., all relevant keys must be known at the start of the homomorphic computation, and the output cannot be usefully combined with ciphertexts encrypted under other keys (unless an expensive "bootstrapping" step is performed). In this work we construct two multi-key FHE schemes, based on LWE assumptions, which are multi-hop with respect to keys: the output of a homomorphic computation on ciphertexts encrypted under a set of keys can be used in further homomorphic computation involving additional keys, and so on. Our systems also have smaller ciphertexts than the previous LWE-based ones; indeed, ciphertexts in our second construction are simply GSW ciphertexts with no auxiliary data.

The paper can be accessed at: https://eprint.iacr.org/2016/196.pdf

Borcherds Products Learning Seminar
Friday, March 18, 2016, 2:30pm-4:00pm
1096 East Hall
Andrew Snowden ()
Heegner divisors and Borcherds products
Applied Interdisciplinary Mathematics  
Friday, March 18, 2016, 3:00pm-4:00pm  
1084 East Hall  
Ihsan Topaloglu (McMaster University)  
*Nonlocal energies defined via attractive-repulsive interaction potentials*

A variety of physical and biological interaction - from self-assembly of nano particles to collective behavior of many-agent systems such as biological swarming - can be modeled via a nonlocal energy. Depending on the choice of the interaction kernel, the asymptotic states of these physical and biological systems can be characterized as minimizers of such energies via a gradient flow connection. In this talk, first, I will present on a joint project with Katy Craig where we show that regularization of singular attractive-repulsive kernels allows us to restore convexity and differentiability; hence enables us to understand the minimizers and the gradient flows of these energies. Next, I will consider the minimization of these energies over sets. Although this nonlocal shape optimization problem poses additional challenges I will discuss the existence/nonexistence of minimizers on certain parameter regimes and present on recent results joint with Almut Burchard and Rustum Choksi.

Combinatorics  
Friday, March 18, 2016, 3:10pm-4:00pm  
4088 East Hall  
Mihai Ciucu (U. Indiana)  
*Lozenge tilings with gaps in a 90 degree wedge domain with mixed boundary conditions*

We consider a triangular gap of side two in a 90 degree angle on the triangular lattice with mixed boundary conditions: a constrained, zig-zag boundary along one side, and a free lattice line boundary along the other. We study the interaction of the gap with the corner as the rest of the angle is completely filled with lozenges. We show that the resulting correlation is governed by the product of the distances between the gap and its three images in the sides of the angle. This provides evidence for a unified way of understanding the interaction of gaps with the boundary under mixed boundary conditions, which we present as a conjecture. Our conjecture is phrased in terms of the steady state heat flow problem in a uniform block of material in which there are a finite number of heat sources and sinks. This new physical analogy is equivalent in the bulk to the electrostatic analogy we developed in previous work, but arises as the correct one for the correlation with the boundary.

Geometry  
Friday, March 18, 2016, 4:00pm-5:00pm  
3096 East Hall  
Dylan Thurston (Indiana University)  
*Energies for maps between graphs*
Preprint Algebraic Geometry Seminar  
Friday, March 18, 2016, 4:10pm-5:30pm  
2866 East Hall  
Matt Stevenson (UM)  

*The gonality conjecture on syzygies of algebraic curves of large degree (following Ein and Lazarsfeld)*

http://arxiv.org/abs/1407.4445