

## Weekly Seminar & Events Bulletin

September 17th, 2017 - September 23rd, 2017

### Monday, September 18, 2017

- 2:00pm-4:00pm **Geometry** -- Mickael Crampon (..) *Discussion Session on Hilbert Geometries* -- 3088 East Hall
- 3:00pm-4:00pm **Quant Program Practitioner Seminar** -- Greg Sobczak (Chicago Trading Company) *TBA* -- MH 1401 Mason Hall
- 3:10pm-4:20pm **Group, Lie and Number Theory** -- Mihran Papikian (Penn State) *An overview of the theory of Drinfeld modules (joint with Arithmetic Geometry learning seminar; note special start time)* -- 4088 East Hall
- 4:00pm-5:00pm **Complex Analysis, Dynamics and Geometry** -- Laszlo Lempert (Purdue University) *Extrapolation, a technique to estimate* -- 3096 East Hall
- 4:00pm-6:00pm **Geometry & Physics** -- Nana Cabo-Bizet (University of Guanajuato) *Non abelian T Dualities in Gauged Linear Sigma Models* -- 4096 East Hall
- 4:00pm-5:00pm **Integrable Systems and Random Matrix Theory** -- Guilherme Silva (University of Michigan) *Products of independent random matrices* -- 1866 East Hall
- 4:00pm-5:00pm **Student Combinatorics Seminar** -- Robert Walker (University of Michigan) *"Life hacking" in toric algebras* -- 3866 East Hall
- 4:40pm-6:00pm **Group, Lie and Number Theory** -- Mihran Papikian (Penn State) *Graph laplacians and Drinfeld modular curves (note special start time)* -- 4088 East Hall

### Tuesday, September 19, 2017

- 3:00pm-4:00pm **Financial/Actuarial Mathematics** -- Johannes Muhle-Karbe (Carnegie Mellon) *Equilibrium Price Impact* -- 4096 East Hall
- 3:00pm-4:00pm **Student Geometry/Topology** -- Feng Zhu (University of Michigan) *What are (and why) Anosov representations?* -- 1866 East Hall
- 3:00pm-4:00pm **Student Commutative Algebra** -- Several Of Us (University of Michigan) *Bring Your Work to Work Day* -- 4088 East Hall
- 4:10pm-5:00pm **Colloquium Series** -- Jun Zhang (University of Michigan) *Information Geometry: Geometrization of Statistical Inference and Information* -- 1360 East Hall

### Wednesday, September 20, 2017

- 3:00pm-5:30pm **RTG Seminar on Geometry, Dynamics and Topology** -- Clark Butler (U Chicago) *Lyapunov spectra and quasiconformal structures for geodesic flows* -- 3866 East Hall
- 3:00pm-4:00pm **Student Arithmetic** -- Yifeng Huang (UM) *Quadratic Forms* -- 3866 East Hall
- 4:10pm-5:30pm **Algebraic Geometry** -- Remy van Dobben de Bruyn (Columbia University) *Dominating varieties by liftable ones* -- 4096 East Hall

### Thursday, September 21, 2017

- 3:00pm-4:00pm **Topology** -- Ayla Sanchez (Wheaton College) *Growth of Higher Baumslag-Solitar Groups* -- 1866 East Hall
- 4:00pm-5:00pm **Differential Equations** -- Rodolfo Torres (University of Kansas) *Smoothing properties of bilinear operators and Leibniz-type rules for fractional derivatives* -- 4088 East Hall
- 4:00pm-5:30pm **Logic** -- Simon Cho (University of Michigan) *A Category Theoretic Perspective on Continuous Logic* -- 3096 East Hall
- 4:10pm-5:30pm **Preprint Algebraic Geometry Seminar** -- Martin Ulirsch (UM) *On Endomorphisms of Arrangement Complements (following Kurul-Werner)* -- 1866 East Hall

**Weekly Seminar & Events Bulletin**  
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Friday, September 22, 2017

- 3:00pm-5:00pm **Geometry** -- Clark Butler (U Chicago) *Characterizing symmetric spaces by their Lyapunov spectra* -- 3866 East Hall
- 3:00pm-4:00pm **Applied Interdisciplinary Mathematics** -- Ian Tobasco (University of Michigan) *The optimal design of wall-bounded heat transport* -- 1084 East Hall
- 3:10pm-4:00pm **Student Algebraic Geometry** -- Takumi Murayama (UM) *Poincare homology spheres and exotic spheres from links of hypersurface singularities* -- 3096 East Hall
- 4:00pm-5:00pm **Geometry** -- Mehrdad Shahshahani (Sharif University of Technology, Tehran) *Are "children's drawings" good for anything?* -- 3866 East Hall
- 4:00pm-5:30pm **Arithmetic Geometry Learning Seminar** -- Shubhodip Mondal (UM) *The Carlitz module, part 2* -- 1866 East Hall
- 4:10pm-5:00pm **Combinatorics** -- Oliver Pechenik (U. Michigan) *Decompositions of Grothendieck polynomials* -- 4088 East Hall
- 4:10pm-5:00pm **Student AIM Seminar** -- Nathan Vaughn (University of Michigan) *Modeling and Simulating Damage Evolution in Brittle Solids* -- 1084 East Hall

**Abstracts for the week of September 17th, 2017 - September 23rd, 2017**

**Geometry**

**Monday, September 18, 2017, 2:00pm-4:00pm**

**3088 East Hall**

**Mickael Crampon (..)**

*Discussion Session on Hilbert Geometries*

We will discuss various notions and ideas in Hilbert geometry.

**Quant Program Practitioner Seminar**

**Monday, September 18, 2017, 3:00pm-4:00pm**

**MH 1401 Mason Hall**

**Greg Sobczak (Chicago Trading Company)**

*TBA*

**Group, Lie and Number Theory**

**Monday, September 18, 2017, 3:10pm-4:20pm**

**4088 East Hall**

**Mihran Papikian (Penn State)**

*An overview of the theory of Drinfeld modules (joint with Arithmetic Geometry learning seminar; note special start time)*

Drinfeld modules (originally called elliptic modules) were introduced by Drinfeld in the early 1970s. His construction evolved from trying to extend the well-known analogy between number fields and function fields to the part of number theory that deals with modular forms and modular curves. The theory of Drinfeld modules and their generalizations soon turned out to be a powerful tool that allowed successful resolution of various problems in the arithmetic of function fields, such as global and local Langlands conjectures, the Stark conjectures and explicit class field theory. In this talk I will review some of the aspects of the theory of Drinfeld modules, with many explicit examples. The talk should be accessible to graduate students.

**Complex Analysis, Dynamics and Geometry**

**Monday, September 18, 2017, 4:00pm-5:00pm**

**3096 East Hall**

**Laszlo Lempert (Purdue University)**

*Extrapolation, a technique to estimate*

I will discuss a method to estimate a Banach space operator by embedding it in a family  $A_t$  of operators,  $\sigma < t < \infty$ , with suitable curvature properties. One can then estimate the norm of each  $A_t$  by bounds that hold in the limit as  $t$  tends to  $\sigma$  and  $\infty$ , respectively.

**Weekly Seminar & Events Bulletin**  
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**Geometry & Physics**

**Monday, September 18, 2017, 4:00pm-6:00pm**  
**4096 East Hall**

**Nana Cabo-Bizet (University of Guanajuato)**

*Non abelian T Dualities in Gauged Linear Sigma Models*

We recall the well studied Abelian T-duality on 2d (2,2) Gauge Linear Sigma Models (GLSM) as a gauging of a global  $U(1)$  symmetry with the addition of Lagrange multipliers. We extend this construction to GLSMs with global non-Abelian symmetries, which are T-dualized. We obtain the equations of motion describing the dual model and solve them for  $SU(2)$  global symmetry with a choice of a particular Lie algebra direction for the vector superfield. This choice leads to a family of Abelian dualities. The Lagrangian of the dual model is obtained in terms of twisted chiral superfields and a twisted superpotential is generated. We address some non-perturbative aspects by making an Ansatz for the instanton corrections in the dual theories. As a result, we verify that the effective potential for the  $U(1)$  gauge field on the original theory matches the one of the dual theories. Exploring the non abelian duality for a choice of vector superfield, some dual vacua can be casted as the family of Abelian dual vacua with further restrictions. For  $SU(2)$  the duality replaces chiral superfields by twisted chiral superfields along the directions of the global symmetry generators. In more general cases the non abelian T-duality leads to a dual model with semi-chiral superfields.

**Integrable Systems and Random Matrix Theory**

**Monday, September 18, 2017, 4:00pm-5:00pm**  
**1866 East Hall**

**Guilherme Silva (University of Michigan)**

*Products of independent random matrices*

This talk will be a gentle survey on products of random matrices from the perspective of a non-specialist. The focus will be on the general picture and recent developments rather than in technical details and proofs.

**Student Combinatorics Seminar**

**Monday, September 18, 2017, 4:00pm-5:00pm**  
**3866 East Hall**

**Robert Walker (University of Michigan)**

*"Life hacking" in toric algebras*

To life hack means figuring out how to make some aspect of your daily life easier or more efficient. As mathematicians, we really want to life hack the study of an unwieldy abstract construction, or of some palatable numeric data, or whatever.

I'll survey some cases of doing this in the ballpark of my research area, leveraging "ALGECOM" info (algebra-geometry-combinatorics), at the interface between asymptotic and combinatorial commutative algebra. While familiarity with notions in Math 614/631 is helpful, everyone is welcome to attend the talk.

**Weekly Seminar & Events Bulletin**  
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**Group, Lie and Number Theory**  
**Monday, September 18, 2017, 4:40pm-6:00pm**  
**4088 East Hall**  
**Mihran Papikian (Penn State)**

*Graph laplacians and Drinfeld modular curves (note special start time)*

The relationship between combinatorial laplacians and automorphic forms is an active area of current research with applications to a variety of problems arising in number theory, group theory, and coding theory. I will discuss certain combinatorial laplacians arising in the theory of Drinfeld modular curves, and their applications to estimating congruences between automorphic forms.

**Financial/Actuarial Mathematics**  
**Tuesday, September 19, 2017, 3:00pm-4:00pm**  
**4096 East Hall**  
**Johannes Muhle-Karbe (Carnegie Mellon)**

*Equilibrium Price Impact*

We derive the equilibrium price at which the order of a large trader are absorbed by a liquidity provider, who can gradually transfer these positions to a market of end users at a cost.

(Joint work in progress with Peter Bank and Ibrahim Ekren)

**Student Geometry/Topology**  
**Tuesday, September 19, 2017, 3:00pm-4:00pm**  
**1866 East Hall**  
**Feng Zhu (University of Michigan)**

*What are (and why) Anosov representations?*

The study of hyperbolic manifolds and their fundamental groups leads us to lattices as a natural and interesting class of discrete subgroups of Lie groups. A generalization of this class, which encompasses a richer range of examples while retaining some of its good geometrical properties, is given by the Anosov condition, which has figured prominently in the emerging field of higher Teichmüller theory. I will describe and motivate the Anosov condition, and give examples of Anosov representations. No background will be assumed, other than slight familiarity with the words "hyperbolic manifold" and "fundamental group".

**Student Commutative Algebra**  
**Tuesday, September 19, 2017, 3:00pm-4:00pm**  
**4088 East Hall**  
**Several Of Us (University of Michigan)**

*Bring Your Work to Work Day*

A few of us will take turns presenting on recent work or some example(s) of interest to us.

**Weekly Seminar & Events Bulletin**  
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**Colloquium Series**

**Tuesday, September 19, 2017, 4:10pm-5:00pm**  
**1360 East Hall**

**Jun Zhang (University of Michigan)**

*Information Geometry: Geometrization of Statistical Inference and Information*

Information Geometry is the differential geometric study of the manifold of probability models, and promises to be a unifying geometric framework for investigating statistical inference, information theory, machine learning, etc. Instead of using metric for measuring distances on such manifolds, these applications often use "divergence functions" for measuring proximity of two points (that do not impose symmetry and triangular inequality), for instance Kullback-Leibler divergence, Bregman divergence, f-divergence, etc. Divergence functions are tied to generalized entropy (for instance, Tsallis entropy, Renyi entropy, phi-entropy) and cross-entropy functions widely used in machine learning and information sciences. It turns out that divergence functions enjoy pleasant geometric properties--they induce what is called "statistical structure" on a manifold  $M$ : a Riemannian metric  $g$  together with a pair of torsion-free affine connections  $D, D^*$ , such that  $D$  and  $D^*$  are both Codazzi coupled to  $g$  while being conjugate to each other. Divergence functions also induce a natural symplectic structure on the product manifold  $M \times M$  for which  $M$  with statistical structure is a Lagrange submanifold. We recently characterize holomorphicity of  $D, D^*$  in the (para-)Hermitian setting, and show that statistical structures (with torsion-free  $D, D^*$ ) can be enhanced to Kahler or para-Kahler manifolds. The surprisingly rich geometric structures and properties of a statistical manifold open up the intriguing possibility of geometrizing statistical inference, information, and machine learning in string-theoretic languages.

**RTG Seminar on Geometry, Dynamics and Topology**

**Wednesday, September 20, 2017, 3:00pm-5:30pm**  
**3866 East Hall**

**Clark Butler (U Chicago)**

*Lyapunov spectra and quasiconformal structures for geodesic flows*

In this talk we give background on the dynamics of the geodesic flow for locally symmetric spaces of variable negative curvature (such as complex hyperbolic manifolds). We describe the structures associated to the geodesic flow which survive under perturbation of the metric. We then relate the structure of the Lyapunov spectrum of the geodesic flow of these perturbed metrics to the existence of certain horizontal quasiconformal structures on unstable horospheres. We will use these structures in the second talk to locally characterize closed negatively curved locally symmetric spaces up to isometry by their Lyapunov spectra.

**Weekly Seminar & Events Bulletin**  
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**Student Arithmetic**

**Wednesday, September 20, 2017, 3:00pm-4:00pm**

**3866 East Hall**

**Yifeng Huang (UM)**

*Quadratic Forms*

This is a quick lecture about the classical theory of positive definite quadratic forms, in a style convenient for modern people. I will start from the basics, including the reduction theory, the correspondence between quadratic forms and ideals of orders of imaginary quadratic fields, and the composition of forms. Next, I will address a key question from ancient: what numbers (especially primes) are represented by a quadratic form? Some remarkable results include genus theory, classification of representable primes by congruence, and Hasse local-global principle, all of which are closely related to class field theory. Time permitting, I will sketch a class field theoretic approach to one of these.

Reference: David Cox, Primes of the form  $x^2+ny^2$

**Algebraic Geometry**

**Wednesday, September 20, 2017, 4:10pm-5:30pm**

**4096 East Hall**

**Remy van Dobben de Bruyn (Columbia University)**

*Dominating varieties by liftable ones*

Given a smooth projective variety over an algebraically closed field of positive characteristic, can we always dominate it by another smooth projective variety that lifts to characteristic 0? We give a negative answer to this question.

**Weekly Seminar & Events Bulletin**  
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**Topology**

**Thursday, September 21, 2017, 3:00pm-4:00pm**  
**1866 East Hall**

**Ayla Sanchez (Wheaton College)**

*Growth of Higher Baumslag-Solitar Groups*

For a (finitely generated) group  $G$  and a given (finite) set of generators  $\mathcal{S}$ , one can define the growth function  $\sigma_{\mathcal{S}}(n)$  to be the function that spits out the number of group elements of length  $n$ . From this we can take a generating function where the coefficient of  $x^n$  is  $\sigma(n)$ . In doing so, one can ask if the generating function is a rational function, in which case we say the group has rational growth in that generating set, which implies several nice properties about the language of geodesics.

One class of groups in which growth is studied is the class of Baumslag-Solitar groups  $BS(p,q)$ . I will particularly focus on  $BS(1,3)$ , which is a solvable group that has rational growth in standard generators. In this talk I will define all of these things I said above, as well as give a class of HNN extensions generalizing Baumslag-Solitar that we call the higher Baumslag-Solitar groups. The main result will be the rationality of the growth of a particular solvable class of higher Baumslag-Solitar groups generalizing  $BS(1,3)$ . Time permitting, I will discuss some future directions.

This work is joint with Michael Shapiro.

**Differential Equations**

**Thursday, September 21, 2017, 4:00pm-5:00pm**  
**4088 East Hall**

**Rodolfo Torres (University of Kansas)**

*Smoothing properties of bilinear operators and Leibniz-type rules for fractional derivatives*

We prove that bilinear fractional integral operators and similar multipliers are smoothing in the sense that they improve the regularity of functions. We also treat bilinear singular multiplier operators which preserve regularity and obtain several Leibniz-type rules in the contexts of Lebesgue and mixed Lebesgue spaces.



**Weekly Seminar & Events Bulletin**  
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**Logic**

**Thursday, September 21, 2017, 4:00pm-5:30pm**  
**3096 East Hall**

**Simon Cho (University of Michigan)**

*A Category Theoretic Perspective on Continuous Logic*

Although classical model theory is largely formulated in terms of the framework of sets, there is a rich theory that casts model theoretic structures in a category theoretic setting, a project which began with Lawvere's thesis on "functorial semantics of algebraic theories" and has since grown into an important subfield of category theory. This interface between classical model theory and category theory continues to be an active area of research today.

In parallel, Lawvere also showed that structures - such as metric spaces - seemingly unrelated to categories arose naturally as examples of categories with appropriate enrichments  $V$  (for example  $V=\mathbb{R}$  in the case of metric spaces). Now continuous logic/metric model theory is a generalization of classical model theory that, roughly, replaces sets with metric spaces and equality with the metric; a natural question to ask is whether the above perspective on metric spaces combines with the way of interpreting classical logic into category theory to produce a way to interpret continuous logic into enriched category theory. This talk will answer this in the affirmative, under reasonable conditions. The talk will make every effort to be self-contained, and as such will assume little to no prior knowledge of category theory

**Preprint Algebraic Geometry Seminar**

**Thursday, September 21, 2017, 4:10pm-5:30pm**  
**1866 East Hall**

**Martin Ulirsch (UM)**

*On Endomorphisms of Arrangement Complements (following Kurul-Werner)*

Available at <http://front.math.ucdavis.edu/1708.06260>

**Weekly Seminar & Events Bulletin**  
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**Geometry**

**Friday, September 22, 2017, 3:00pm-5:00pm**

**3866 East Hall**

**Clark Butler (U Chicago)**

*Characterizing symmetric spaces by their Lyapunov spectra*

The Lyapunov spectrum of an invariant measure for a geodesic flow describes the asymptotic exponential growth rates of Jacobi fields along almost every geodesic with respect to this measure. We prove that the geodesic flow of a closed negatively curved locally symmetric space is characterized among nearby smooth flows by the structure of its Lyapunov spectrum with respect to volume. We deduce that these locally symmetric spaces are locally characterized up to isometry by the Lyapunov spectra of their geodesic flows. We will discuss some geometric aspects of the proof, which draw on quasiconformal mapping theory and the geometry of 2-step Carnot groups.

**Applied Interdisciplinary Mathematics**

**Friday, September 22, 2017, 3:00pm-4:00pm**

**1084 East Hall**

**Ian Tobasco (University of Michigan)**

*The optimal design of wall-bounded heat transport*

Flowing a fluid is a familiar and efficient way to cool: fans cool electronics, water cools nuclear reactors, and the atmosphere cools the surface of the Earth. In this talk, we discuss a class of problems from fluid dynamics which ask for the design of incompressible wall-bounded flows achieving optimal rates of heat transport for a given flow intensity budget. Guided by a perhaps unexpected connection between this optimal design problem and various "energy-driven pattern formation" problems from materials science, we construct flows achieving nearly optimal rates of heat transport in their scaling with respect to the intensity budget. The resulting flows share striking similarities with self-similar elastic wrinkling patterns, such as can be seen in the shape of a hanging drape or nearby the edge of a torn plastic sheet. They also remind of (carefully designed versions) of the complex multi-scale patterns seen in turbulent fluids. Nevertheless, we prove that in certain cases natural buoyancy-driven convection is not capable of achieving optimal rates of cooling. This is joint work with Charlie Doering.

**Weekly Seminar & Events Bulletin**  
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**Student Algebraic Geometry**

**Friday, September 22, 2017, 3:10pm-4:00pm**

**3096 East Hall**

**Takumi Murayama (UM)**

*Poincare homology spheres and exotic spheres from links of hypersurface singularities*

Singularities arise naturally in algebraic geometry when trying to classify algebraic varieties. However, they are also a rich source of examples in other fields, particularly in topology. We will explain how complex hypersurface singularities give rise to knots and links, some of which are manifolds that are homologically spheres but not topologically (Poincare homology spheres), or manifolds that are homeomorphic to spheres but not diffeomorphic to them (exotic spheres). The talk should be accessible to anyone with some basic knowledge of differential and algebraic topology, although even that is not strictly necessary.

**Geometry**

**Friday, September 22, 2017, 4:00pm-5:00pm**

**3866 East Hall**

**Mehrdad Shahshahani (Sharif University of Technology, Tehran)**

*Are "children's drawings" good for anything?*

The theory of dessins d'enfants (children's drawings) can be effectively used to make explicit calculations. In principle it allows one to obtain equations for ramified coverings of curves when the ramification data are specified, determine isomorphisms of certain curves or exhibit Jenkins-Strebel differentials in preferred coordinates. However, little progress has been made in utilizing the geometry/combinatorics of dessins for theoretical questions in algebraic number theory. Here we exhibit families of dessins that are geometrically simple and show that they have and/or conjecturally have interesting arithmetical properties.

**Arithmetic Geometry Learning Seminar**

**Friday, September 22, 2017, 4:00pm-5:30pm**

**1866 East Hall**

**Shubhodip Mondal (UM)**

*The Carlitz module, part 2*

**Weekly Seminar & Events Bulletin**  
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**Combinatorics**

**Friday, September 22, 2017, 4:10pm-5:00pm**  
**4088 East Hall**

**Oliver Pechenik (U. Michigan)**

*Decompositions of Grothendieck polynomials*

Finding a combinatorial rule for the Schubert structure constants in the K-theory of flag varieties is a long-standing problem. The Grothendieck polynomials of Lascoux and Schuetzenberger (1982) serve as polynomial representatives for K-theoretic Schubert classes, but no positive rule for their multiplication is known in general. We contribute a new basis for polynomials (in  $n$  variables), give a positive combinatorial formula for the expansion of Grothendieck polynomials in these "glide polynomials," and provide a positive combinatorial Littlewood-Richardson rule for expanding a product of Grothendieck polynomials in the glide basis.

A specialization of the glide basis recovers the fundamental slide polynomials of Assaf and Searles (2016), which play an analogous role with respect to ordinary cohomology. Additionally, the stable limits of another specialization of glide polynomials are Lam and Pylyavskyy's (2007) basis of multi-fundamental quasisymmetric functions, K-theoretic analogues of Gessel's (1984) fundamental quasisymmetric functions. Those glide polynomials that are themselves quasisymmetric are truncations of multi-fundamental quasisymmetric functions and form a basis of quasisymmetric polynomials. (Joint work with Dominic Searles.)

**Student AIM Seminar**

**Friday, September 22, 2017, 4:10pm-5:00pm**  
**1084 East Hall**

**Nathan Vaughn (University of Michigan)**

*Modeling and Simulating Damage Evolution in Brittle Solids*

Brittle materials are important for many applications ranging from the concrete structures to Beryllium aircraft parts. Crack growth and coalescence leads to the weakening and failure of brittle materials. The physics of crack growth is complex and modeling is largely limited to simple idealized settings. Simulations are difficult from both a physical accuracy and a computational complexity perspective. In this talk I will give an introduction to solid mechanics and damage modeling, then explain some of the experimental and computational challenges. I will present preliminary results as proof of concept for a crack-statistics scale bridging approach that enables a large scale simulation to account for damage due to cracks too small to resolve.