

Winter 2009  
University of Michigan-Department of Mathematics  
<http://www.math.lsa.umich.edu/seminars/index.shtml>  
Ann Arbor, MI 48109-1043  
**February 16th – February 22nd**

**Monday, February 16**

- 3:10-4:00pm **Topics in Algebraic Geometry Seminar** --- Victor Lozovanu (UM) *Existence of quotients* --- 2866 EH
- 3:10-5:00pm **Group Theory/Lie Theory/Number Theory Seminar** --- Donald Cartwright (Sydney) *Fifty fake projective planes* --- 4096 EH
- 4:10-5:00pm **Student Combinatorics** --- Kevin Dilks (UM) *Promotion and Evacuation* --- 3866 EH
- 4:10-6:00pm **Geometry and Physics Seminar** --- David Treumann (Minnesota) *Coherent sheaves, constructible sheaves, and homological mirror symmetry for toric varieties* --- 4088 EH
- 5:15-6:30pm **Teaching Mathematics** --- Matt Elsey (UM) & Jeff Meyer (UM) *Analysis Of Classroom Objectives: Conception to Perception* --- 3096 EH

**Tuesday, February 17**

- 2:10-3:00pm **"What is ... " Seminar** --- Les Saper (Duke) *What is ... intersection homology?* --- 3096 EH
- 3:10-4:00pm **Several Complex Variables and Complex Dynamics Seminar - Special Seminar (Non-standard Day/Time/Location)** --- Aron Lagerberg (Chalmers University of Technology) *An analyticity theorem for a generalized Lelong number* --- 3088 EH
- 3:10-4:00pm **Algebra Seminar** --- TBA --- 3096 EH
- 3:10-4:00pm **Geometry Seminar** --- Eduardo Martinez Pedroza (McMaster) *Separation of Quasiconvex Subgroups* --- 3866 EH
- 3:10-4:00pm **Student Algebraic Geometry Seminar** --- Zhixian Zhu (UM) *Classification of surface singularities* --- 3088 EH
- 3:10-4:00pm **Student Seminar in Complex Dynamical Systems** --- TBA --- 4088 EH
- 4:10-5:00pm **Colloquium** --- Les Saper (Duke) *Cohomology of Locally Symmetric Spaces* --- 1360 EH
- 4:10-5:00pm **Student AIM Seminar** --- TBA --- 3088 EH
- 5:00-6:00pm **Social Hour** – Upper Atrium

**Wednesday, February 18**

- 3:10-4:00pm **Geometric Function Theory Seminar** --- Marshall Williams (UM) *Metric currents and differentiable structures* --- 4096 EH
- 3:10-4:00pm **Student Representation Theory Seminar** --- Ricardo Portilla (UM) *Representation Theory of  $sl_2(k)$ , for  $k$  of "good" characteristic* --- 3096 EH
- 3:10-4:00pm **Student Arithmetic Seminar** --- Ben Weiss (UM) *An Introduction to Kissing Numbers* --- 3088 EH
- 4:10-5:00pm **RTG Working Seminar in Several Complex Variables and Complex Dynamics** --- TBA --- 3096 EH
- 4:10-6:00pm **Algebraic Geometry Seminar** --- David Witt Nyström (Gothenberg University) *Chebyshev functions on Okounkov bodies* --- 3088 EH

**Thursday, February 19**

- 3:10-4:00pm **Commutative Algebra Seminar** --- TBA --- 3096 EH
- 3:10-4:00pm **Topology Seminar** --- Kyle Ormsby (UM) *Computations in motivic stable homotopy theory* --- 4088 EH
- 3:10-4:00pm **Financial/Actuarial Mathematics Seminar** --- TBA --- 3088 EH
- 4:10-5:00pm **Differential Equations** --- Mohar Guha (UM) *Bounds on Coarsening rates for the diffusive Lifschitz-Slyozov-Wagner Equation* --- 4088 EH
- 4:10-5:00pm **Math Club** --- Susan Murray (UM-Biostatistics) *Mathematics for a Lifetime: Survival Analysis for Beginners* --- 2<sup>nd</sup> floor Nesbitt Common Room
- 4:10-6:00pm **RTG Study Seminar** --- TBA --- 3866 EH

**Friday, February 20**

- 11:10-12:00pm **Theoretical Computer Science Seminar** --- Carl Miller (UM) *Geometry and quantum entanglement* --- CSE 3941
- 3:10-4:00pm **Applied and Interdisciplinary Mathematics Seminar** --- Fernando Carreon (UM) *Front Propagation in a Reaction Diffusion Equation with a Bistable Nonlinearity* --- 1084 EH
- 3:10-4:00pm **Student Geometry/Topology** --- Not meeting this week --- 3096 EH
- 4:10-5:00pm **Combinatorics** --- TBA --- 3866 EH

**UPCOMING EVENTS**

**RTG Workshop On SCV and Geometry  
Apr. 10 - Apr. 12, 2009**

**ABSTRACTS FOR THE WEEK OF FEB. 16 – FEB. 22, 2009**

**Group Theory/Lie Theory/Number Theory Seminar  
Monday, February 16, 3:10-5:00pm  
4096 EH  
Donald Cartwright (Sydney)  
*Fifty fake projective planes***

Fake projective planes are smooth compact complex surfaces that are not the complex projective plane, but have the same Betti numbers as the complex projective plane. They are determined by their fundamental group. In their 2007 Inventiones paper, Gopal Prasad and Sai-Kei Yeung showed that these fundamental groups are the torsion free subgroups  $\Pi$ , with finite abelianization, of index  $3\chi(\bar{\Gamma})$  in a maximal arithmetic subgroup  $\bar{\Gamma}$  of  $PU(2,1)$ . They show that only a small number of  $\bar{\Gamma}$  can arise, and list them explicitly. I will give a report of some of the work Tim Steger and I have been doing to find all the possible groups  $\Pi$  for all of these  $\bar{\Gamma}$ 's, by finding explicit generators and relations for each of these groups.

**Student Combinatorics**  
**Monday, February 16, 4:10-5:00pm**  
**3866 EH**  
**Kevin Dilks (UM)**  
***Promotion and Evacuation***

Promotion and evacuation are two operations based off of jeu de taquin which give automorphisms on the set of linear extensions of a partially ordered set, and they happen to show up in some interesting places. To start, I'll derive some of the classical relations between the two operations. Then I'll move on to a couple different applications where promotion and evacuation come into play, including some recent results and conjectures related to the cyclic sieving phenomenon.

**Geometry and Physics Seminar**  
**Monday, February 16, 4:10-6:00pm**  
**4088 EH**  
**David Treumann (Minnesota)**  
***Coherent sheaves, constructible sheaves, and homological mirror symmetry for toric varieties***

This is a talk on joint work with Bohan Fang, Chiu-Chu Melissa Liu, and Eric Zaslow. An ample, equivariant line bundle on a toric variety  $X$  determines a polytope in  $\mathbb{R}^n$ . We extend this correspondence to an equivalence between the derived category of equivariant coherent sheaves on  $X$  and a certain derived category of constructible sheaves on  $\mathbb{R}^n$ . We connect this result to mirror symmetry through a recent theorem of Nadler and Zaslow, which identifies the category of constructible sheaves on  $\mathbb{R}^n$  with a Fukaya category of Lagrangian submanifolds of the cotangent bundle.

**Teaching Mathematics**  
**Monday, February 16, 5:15-6:30pm**  
**3096 EH**  
**Matt Elsey (UM) & Jeff Meyer (UM)**  
***Analysis Of Classroom Objectives: Conception to Perception***

When planning a lesson, teachers are advised to begin by identifying their objectives for that lesson. To better understand how these objectives are understood by students at the end of the lesson, we analyzed several introductory mathematics classes at the University of Michigan. Our analysis included interviewing the teacher before the lesson, observing the lesson, and then questioning students after the lesson. Our findings point to frequent discrepancies between the objectives of the teacher and the objectives perceived by the students. We discuss these results, and possible ways to ensure that students' understandings more closely match the teacher's objectives.

**“What is ... ” Seminar**  
**Tuesday, February 17, 2:10-3:00pm**  
**3096 EH**  
**Les Saper (Duke)**  
***What is ... intersection homology?***

The homology of a compact closed  $n$ -manifold  $X$  satisfies Poincaré duality: the intersection pairing between degree  $i$  and degree  $n-i$  homology is a perfect pairing over a field. When  $X$  has singularities, Poincaré duality may fail to hold. Nonetheless, in the 1980's Goresky and MacPherson defined a topological invariant, the intersection homology, of a space  $X$  which satisfies Poincaré duality even if  $X$  is singular; for a smooth space  $X$ , intersection homology agrees with ordinary homology. Intersection homology crops up in many places, from analysis to representation theory. In this talk I will give an informal introduction to intersection homology and some of its applications.

**Several Complex Variables and Complex Dynamics Seminar - Special Seminar**  
**(Non-standard Day/Time/Location)**  
**Tuesday, February 17, 3:10-4:00pm**  
**3088 EH**  
**Aron Lagerberg (Chalmers University of Technology)**  
***An analyticity theorem for a generalized Lelong number***

Lelong numbers, introduced by Pierre Lelong in the 50's, provide us with a way of measuring singularities of plurisubharmonic functions. I will discuss a generalization of Lelong numbers, introduced by Bo Berndtsson, and prove that they satisfy an analyticity property. More precisely, we prove that, for  $c > 0$ , the upper level set  $\{x \in \Omega : \nu_{x, \psi}(f) \geq c\}$  defines an analytic set in  $\Omega$ , where  $\nu_{x, \psi}(f)$  denotes Berndtsson's generalized Lelong number of  $f$ , with respect to a sufficiently nice function  $\psi$ , at the point  $x$ . For  $\psi = (n-1) \log|z|$ , this number is just the classical Lelong number, and we obtain the classical semi-continuity theorem as proved by Siu in 1974.

**Geometry Seminar**  
**Tuesday, February 17, 3:10-4:00pm**  
**3866 EH**  
**Eduardo Martinez Pedroza (McMaster)**  
***Separation of Quasiconvex Subgroups***

We study the class of relatively hyperbolic groups and their geometric subgroups which are called quasi-convex. For example, the fundamental group of a finite volume hyperbolic 3-manifold group is a hyperbolic group relative to the cusp groups and a subgroup induced by a quasi-Fuchsian surface is quasi-convex.

In this talk, I'll explain recent work on the theory of quasi-convex sub-groups of relatively hyperbolic groups. In particular, the combination theorems for quasi-convex subgroups and applications to subgroup separability. Some applications to Kleinian groups will be discussed.

**Colloquium**  
**Tuesday, February 17, 4:10-5:00pm**  
**1360 EH**  
**Les Saper (Duke)**  
***Cohomology of Locally Symmetric Spaces***

The upper half-plane modulo the action of  $SL(2, \mathbb{Z})$  by fractional linear transformations is the archetypal example of an arithmetically defined locally symmetric space. These spaces play an important role in geometry, representation theory, and number theory. Associated to a locally symmetric space (and its compactifications) are several types of cohomology. In the talk I will use the general theme of relating analytic and topological invariants to introduce these compactifications and cohomology theories and motivate results relating them.

**Geometric Function Theory Seminar**  
**Wednesday, February 18, 3:10-4:00pm**  
**4096 EH**  
**Marshall Williams (UM)**  
***Metric currents and differentiable structures***

In 2000 Ambrosio and Kirchheim extended the Federer-Fleming theory of currents to general metric spaces. Around the same time Cheeger introduced the notion of a differentiable structure in similar generality.

Using this concept he proved a version of Rademacher's theorem on differentiability of Lipschitz functions. I will discuss the compatibility of Cheeger's differentiable structures with the Ambrosio-Kirchheim theory.

**Student Representation Theory Seminar**  
**Wednesday, February 18, 3:10-4:00pm**  
**3096 EH**  
**Ricardo Portilla (UM)**  
***Representation Theory of  $sl_2(k)$ , for  $k$  of "good" characteristic***

Let  $(\rho, V)$  be a finite-dimensional representation of  $sl_2(k)$  for  $k$  algebraically closed and of "good" characteristic. Then we'll mention basic facts like complete reducibility of  $(\rho, V)$  and discuss the weights of irreducible representations and the decomposition of finite-dimensional Lie algebras under the  $sl_2$ -action. This will lead to the description of the root spaces in the paper by Crawley-Boevey.

**Student Arithmetic Seminar**  
**Wednesday, February 18, 3:10-4:00pm**  
**3088 EH**  
**Ben Weiss (UM)**  
***An Introduction to Kissing Numbers***

This will be a survey talk on spheres, sphere packing, and kissing numbers. We'll go over definitions, conjectures, basic results, and a few constructions and proofs. This talk should be accessible to all.

**Algebraic Geometry Seminar**  
**Wednesday, February 18, 4:10-6:00pm**  
**3088 EH**  
**David Witt Nystroem (Gothenberg University)**  
***Chebyshev functions on Okounkov bodies***

In their article Convex Bodies associated to Linear Series, Lazarsfeld-Mustata instigated a systematic study of Okounkov bodies of divisors, and more generally of linear series. We wish to contribute with an analytic viewpoint. Namely, given a continuous metric on a big line bundle, we show how to construct an associated convex function on the Okounkov body of the line bundle, which we will call the Chebyshev function of the metric.

The main motivation for studying Okounkov bodies has been their connection to the volume function on divisors. We are however interested in studying certain functionals on the space of metrics. E.g. there is a notion of the relative energy of two metrics. Our main result is that this relative energy is given by the integral of the difference of the Chebyshev functions over the Okounkov body of the corresponding line bundle, times a constant that only depends on the dimension.

We will discuss why this can be seen as a generalization of the result that the volume of a divisor is equal to the volume of its Okounkov body, times a constant, and also how it generalizes results from toric geometry.

If there is time, we might also discuss how the proof of the differentiability of the volume by Lazarsfeld-Mustata can be modified to yield the differentiability of the relative energy, at least in the ample cone.

**Topology Seminar**  
**Thursday, February 19, 3:10-4:00pm**  
**4088 EH**  
**Kyle Ormsby (UM)**  
***Computations in motivic stable homotopy theory***

The Morel-Voevodsky motivic homotopy category provides a framework in which homotopy-theoretic constructions and techniques can be applied to algebraic varieties. Until recently, though, few computations were known beyond those done by Voevodsky. After introducing motivic homotopy theory, I will present some motivic versions of spectral sequences from topology. In topology, these are used in calculations of stable homotopy groups, while their motivic analogues converge to motivic stable homotopy groups, which are already known to be deep objects related to the theory of quadratic forms and other arithmetic structures. I will give some examples providing new information about these groups.

**Differential Equations**  
**Thursday, February 19, 4:10-5:00pm**  
**4088 EH**  
**Mohar Guha (UM)**  
***Bounds on Coarsening rates for the diffusive Lifschitz-Slyozov-Wagner Equation***

This talk is concerned with the large time behaviour of the solutions of diffusive Lifschitz-Slyozov-Wagner equations which exhibit the property of coarsening. In order to study point-wise in time bounds on the rate of coarsening we look at a problem in stochastic control theory which turns up. We show the connection between these bounds and the convexity of the stochastic control theory problem.

**Math Club**  
**Thursday, February 19, 4:10-5:00pm**  
**2<sup>nd</sup> floor Nesbitt Common Room**  
**Susan Murray (UM-Biostatistics)**  
***Mathematics for a Lifetime: Survival Analysis for Beginners***

Survival analysis involves both mathematical and statistical theory applied to important health research questions. This talk introduces survival data and showcases several important applications of survival analysis in clinical trials and transplantation research. This field of study incorporates ideas from simple sample proportions and graphics to sophisticated martingale theory, and is ever-growing. To find out more about how mathematical and probabilistic thinking continues to influence the nation's health, do attend.

**Theoretical Computer Science Seminar**  
**Friday, February 20, 11:10-12:00p**  
**CSE 3941**  
**Carl Miller (UM)**  
***Geometry and quantum entanglement***

Quantum computing is based on quantum systems, i. e., sets of particles whose states are undetermined. A problem in quantum computing is to describe equivalence classes of quantum systems that are distributed among  $n$  parties. If  $n = 2$ , this problem has a fairly easy solution; however when  $n = 3$ , it is much harder. In this talk I will present a geometric approach to mapping out some of the equivalence classes for the case  $n = 3$ . The talk is based partly on the paper "Tripartite entanglement transformations and tensor rank" by E. Chitambar, R. Duan, and Y. Shi.

**Applied and Interdisciplinary Mathematics Seminar**  
**Friday, February 20, 3:10-4:00pm**  
**1084 EH**  
**Fernando Carreon (UM)**  
***Front Propagation in a Reaction Diffusion Equation with a Bistable Nonlinearity***

In this talk I provide a proof that justifies the formal asymptotic argument developed by H. Fan and S. Ji for the long time behavior of the solutions to a reaction diffusion equation. The structure of the reaction term provides this equation with two stable constant equilibrium solutions  $u=-1, 1$  and an unstable equilibrium  $u=0$ . The solutions of this equation, as time goes to infinity, converge to a piecewise constant function attaining the values of the stable equilibria. The boundaries of the regions where the limiting function attains each constant value evolve with a normal velocity that depends on the geometry of these boundaries. I'll describe the evolution of these boundaries using the notion of generalized flows developed by G. Barles and T. Souganidis.