

Fall 2008
University of Michigan-Department of Mathematics
<http://www.math.lsa.umich.edu/seminars/index.shtml>
Ann Arbor, MI 48109-1043
October 6th – October 12th

Monday, October 6

- 12:10-1:00pm **Special Algebraic Geometry Seminar (Note: Time/Location)** --- János Kollár (Princeton University) *Log canonical implies Du Bois* --- 4096 EH
- 3:10-4:00pm **Topics in Algebraic Geometry Seminar** --- Kevin Tucker (UM) *Fano Varieties are Rationally Connected (Bend and Break)* --- 2866 EH
- 3:10-5:00pm **Group Theory/Lie Theory/Number Theory Seminar (Special Series, Part 1)** --- Mitya Boyarchenko (Chicago) *Character sheaves on unipotent groups in positive characteristic* --- 4096 EH
- 4:10-5:00pm **Several Complex Variables and Complex Dynamics Seminar** --- Not meeting this week --- 3096 EH
- 4:10-5:00pm **Student Combinatorics** --- Not meeting this week --- 3866 EH
- 5:15-6:30pm **Teaching Mathematics** --- Not meeting this week --- 3096 EH

Tuesday, October 7

- 1:10-2:00pm **Special Colloquium (Note: Time/Location)** --- János Kollár (Princeton University) *Cremona transformations and homeomorphisms of topological surfaces* --- 2866 EH
- 3:10-4:00pm **Geometry Seminar** --- John Lott (UM) *Optimal transport and Perelman's reduced volume* --- 4096 EH
- 3:10-4:00pm **Algebra Seminar** --- Farkhod Eshmatov (UM) TBA --- 3096 EH
- 3:10-4:00pm **Student Algebraic Geometry Seminar** --- TBA --- 3088 EH
- 4:10-5:00pm **Colloquium** --- Zoltan Szabo (Princeton University) *Heegaard Floer homology for three-manifolds* --- 1360 EH
- 4:10-5:00pm **Student AIM Seminar** --- Dave Starinshak (UM) *Machine Learning: Adaboost* --- 3088 EH

Wednesday, October 8

- 3:10-4:00pm **Geometric Function Theory Seminar** --- Ignacio Uriarte-Tuero (MSU) *Astala's conjecture on Hausdorff measure distortion under planar quasiconformal mappings* --- 4096 EH
- 3:10-4:00pm **Student Representation Theory Seminar** --- Ricardo Portilla (UM) *The Steinberg representation* --- 3096 EH
- 3:10-4:00pm **Student Arithmetic Seminar (rescheduled from last week)** --- Hester Graves (UM) *The Fibonacci-Adics* --- 3866 EH
- 3:10-5:00pm **Group Theory/Lie Theory/Number Theory Seminar (Special Series, Part 2)** --- Mitya Boyarchenko (Chicago) *Character sheaves on unipotent groups in positive characteristic* --- 4088 EH (Note: Alternate location)
- 4:10-5:00pm **RTG Working Seminar in Several Complex Variables and Complex Dynamics** --- Zhou Zhang (UM) *Relative capacity and comparison principle* --- 3096 EH
- 4:10-6:00pm **Algebraic Geometry Seminar** --- Matthew Simpson (UM) *Moduli Spaces of Weighted Conics* --- 3088 EH

Thursday, October 9

- 3:10-4:00pm **Commutative Algebra Seminar** --- Emily Witt (UM) *Pretalk* --- 3096 EH
- 3:10-4:00pm **Financial/Actuarial Mathematics Seminar** --- Not meeting this week --- 3088 EH
- 3:10-6:00pm **Topology & Geometry/Physics (Joint Seminar)** --- Stephan Stolz (Notre Dame) *Supersymmetric Euclidean field theories and generalized cohomology* --- 4096 EH
- 4:10-5:00pm **Differential Equations** --- Paul Kessenich (UM) *Global Existence for a 3D Incompressible Isotropic Viscoelastic Material* --- 4088 EH

Thursday, October 9 ... continued

- 4:10-5:00pm **Math Club** --- Amanda Knecht (UM) *The Mathematics of Sudoku* --- 2nd floor Nesbitt Common Room
- 4:10-5:00pm **Reading Group in Probabilistic Methods in Geometric Functional Analysis and Combinatorics** --- 1360 EH
- 4:10-6:00pm **RTG Study Seminar** --- Not meeting this week --- 3866 EH

Friday, October 10

- 11:10-12:00pm **Theoretical Computer Science Seminar** --- Xi Chen (UM) *On the Computation and Approximation of Two-Player Nash Equilibria* --- 1018 DOW
- 3:10-4:00pm **Applied and Interdisciplinary Mathematics Seminar** --- Bernard Deconinck (U of Washington) *Stability of Stationary Periodic Solutions of Nonlinear Wave Equations* --- 1084 EH
- 3:10-4:00pm **Student Geometry/Topology** --- Daniel Kneezel (UM) *What Would You Do with a Steenrod Square?* --- 3096 EH
- 3:10-5:00pm **Group Theory/Lie Theory/Number Theory Seminar (Special Series, Part 3)** --- Mitya Boyarchenko (Chicago) *Character sheaves on unipotent groups in positive characteristic* --- 4088 EH (Note: Alternate location)
- 4:10-5:00pm **Combinatorics** --- Cristian Lenart (SUNY Albany) *On combinatorial formulas for Macdonald polynomials* --- 3866 EH

EVENTS THIS WEEK

Group Theory/Lie Theory/Number Theory Seminar (Special Series)

Monday, October 6, 3:10-5:00pm – Part 1

Wednesday, October 8, 3:10-5:00pm – Part 2

Friday, October 10, 3:10-5:00pm – Part 3

Monday - 4096 EH, Wednesday and Friday - 4088 EH (Note: Alternate Location)

Mitya Boyarchenko (Chicago)

Character sheaves on unipotent groups in positive characteristic

I will give a series of three two-hour lectures devoted to recent advances in the theory of character sheaves on unipotent groups. For the most part, I will restrict attention to groups over an algebraically closed field of characteristic $p > 0$; if time permits, the relation to representation theory of unipotent groups over finite fields will be discussed at the end of the series.

The results that will be presented in my lectures were obtained in collaboration with Vladimir Drinfeld.

Tentatively, the talks will be structured as follows.

The first half of the first lecture will be devoted to a general overview of the subject. I will explain the main definitions of the theory and the motivation behind them, and I will state several fundamental results. The emphasis will be on statements, rather than on the techniques used to prove them. The topics that will be covered are:

- the equivariant derived category of an algebraic group as a geometrization of the algebra of class functions on a finite group (the equivariant derived category is where character sheaves lie);
- the abstract definition of character sheaves and L-packets thereof;
- an explicit construction that yields a description of all L-packets of character sheaves in concrete terms;
- character sheaves on unipotent groups over finite fields and their relation to representations of finite groups.

The other 5 hours of talks will be essentially independent of the first hour. In particular, the first hour will be tailored to the attendee who wishes to get a broad perspective on the subject without delving into technical details. On the other hand, the remainder of the series will be devoted to explaining a collection of basic ideas that lie at the heart of the proofs of the fundamental results of the theory of character sheaves on unipotent groups. Virtually no background (beyond a basic familiarity with algebraic varieties and algebraic groups) will be assumed. To the extent possible, I will try to build the theory "from scratch" (even though many results from the background material will have to be stated without proof).

Understanding (or even being present at) the first hour will NOT be a prerequisite for the other 5 hours. In the "How-To" portion of the lecture series, I plan to start by briefly explaining the sheaves-to-functions philosophy, followed by a definition of the equivariant derived category (to be abbreviated as EDC from now on) of a unipotent group of the main structures present on this category (most notably, the convolution functor, which yields a monoidal category structure).

Next I will discuss the notion of an idempotent in a general monoidal category, and will give the definition of L-packets of character sheaves on unipotent groups in terms of idempotents in the EDC.

The main technical tools of the theory are Serre duality, which is a geometrization of Pontryagin duality for finite abelian groups, and the induction functor from the EDC of a subgroup of a unipotent group to the EDC of the ambient group. Both tools will be presented in a detailed and self-contained manner. Serre duality allows one to formulate the notion of an "admissible pair" for a unipotent group, while induction functors provide a way of constructing L-packets of character sheaves explicitly in terms of admissible pairs. Thus we will be lead to the main results of the theory of character sheaves; I will sketch their proofs and emphasize the essential ideas that drive the arguments.

I will decide on where to proceed from that point, and on what additional material will be included, depending on the interest of the attendees. Please feel free to make suggestions and requests after the introductory part of the lecture series is finished.

Finally, I would like to point out that, while the theory of character sheaves has already achieved some very interesting and nontrivial results, much of the philosophy that underlies the theory can be traced back to classical techniques of character theory for finite groups. One of my main objectives will be to convey this connection between the two theories to the audience.

ABSTRACTS FOR THE WEEK OF OCT. 6 – OCT. 12, 2008

Special Colloquium (Note: Time/Location)

Tuesday, October 7, 1:10-2:00pm

2866 EH

János Kollár (Princeton University)

Cremona transformations and homeomorphisms of topological surfaces

The simplest Cremona transformation of projective 3-space is the involution this is

$$\sigma : (x_0 : x_1 : x_2 : x_3) \mapsto \left(\frac{1}{x_0} : \frac{1}{x_1} : \frac{1}{x_2} : \frac{1}{x_3} \right),$$

which is a homeomorphism outside the “coordinate tetrahedron” ($x_0 x_1 x_2 x_3 = 0$)

By studying the action of σ on real quadric surfaces, we show that σ and its conjugates generate a dense subgroup of $\text{Homeo}(S^2)$, the group of homeomorphisms of the 2-sphere.

Then we show that the same holds if the 2-sphere is replaced by the torus or by any non-orientable surface and explain why there can not be similar results for orientable surfaces of genus ≥ 2 . (Joint work with Frédéric Mangolte.)

Geometry Seminar

Tuesday, October 7, 3:10-4:00pm

4096 EH

John Lott (UM)

Optimal transport and Perelman's reduced volume

We show that a certain entropy-like function is convex, under an optimal transportation problem that is adapted to Ricci flow. We use this to reprove the monotonicity of Perelman's reduced volume.

Colloquium

Tuesday, October 7, 4:10-5:00pm

1360 EH

Zoltan Szabo (Princeton University)

Heegaard Floer homology for three-manifolds

This talk will give an introduction to Heegaard Floer homology for closed oriented three-dimensional manifolds. The invariant is defined with the use of Heegaard decompositions and Lagrangian Floer homology. After describing the construction, we will discuss applications and also some techniques to compute Heegaard Floer homology.

Student AIM Seminar
Tuesday, October 7, 4:10-5:00pm
3088 EH
Dave Starinshak (UM)
Machine Learning: Adaboost

We will continue on our discussion on ensemble methods in machine learning. Dave will describe the Adaboost algorithm, an adaptive technique that is more resistant to overfitting than other machine learning algorithms. We will continue to read from "Ensemble Methods in Machine Learning." From that paper's abstract:

Ensemble methods are learning algorithms that construct a set of classifiers and then classify new data points by taking a weighted vote of their predictions. The original ensemble method is Bayesian averaging but more recent algorithms include error-correcting output coding Bagging, and boosting. This paper reviews these methods and explains why ensembles can often perform better than any single classifier. Some previous studies comparing ensemble methods are reviewed, and some new experiments are presented to uncover the reasons that Adaboost does not overfit rapidly.

Geometric Function Theory Seminar
Wednesday, October 8, 3:10-4:00pm
4096 EH
Ignacio Uriarte-Tuero (MSU)

Astala's conjecture on Hausdorff measure distortion under planar quasiconformal mappings

In his celebrated paper on area distortion under planar quasiconformal mappings (Acta 1994), K. Astala proved that a compact set E of Hausdorff dimension d is mapped under a K -quasiconformal map f to a set fE of Hausdorff dimension at most $d' = \frac{2Kd}{2+(K-1)d}$, and he proved that this result is sharp. He conjectured (Question 4.4) that if the Hausdorff measure $\mathcal{H}^d(E) = 0$, then $\mathcal{H}^{d'}(fE) = 0$.

This conjecture was known to be true if $d = 0$ (obvious), $d = 2$ (Ahlfors), and more recently $d = 1$ (Astala, Clop, Mateu, Orobitg and UT, Duke 2008.) The approach in the last mentioned paper does not generalize to other dimensions.

Astala's conjecture was shown to be sharp (if it was true) in the class of all Hausdorff gauge functions in work of UT (IMRN, 2008).

Finally, Lacey, Sawyer and UT jointly proved completely Astala's conjecture in all dimensions. The ingredients of the proof come from Astala's original approach, geometric measure theory, and some new weighted norm inequalities for Calderón-Zygmund singular integral operators which cannot be deduced from the classical Muckenhoupt A_p theory.

These results are intimately related to (not yet fully understood) removability problems for various classes of quasiregular maps.

The talk will be self-contained.

Student Representation Theory Seminar
Wednesday, October 8, 3:10-4:00pm
3096 EH
Ricardo Portilla (UM)
The Steinberg representation

We'll provide the necessary background to define and illustrate the importance of the Steinberg representation for finite groups of Lie type.

Student Arithmetic Seminar (rescheduled from last week)
Wednesday, October 8, 3:10-4:00pm
3866 EH
Hester Graves (UM)
The Fibonacci-Adics

We will define, and explain, the Fibonacci-Adics.

RTG Working Seminar in Several Complex Variables and Complex Dynamics
Wednesday, October 8, 4:10-5:00pm
3096 EH
Zhou Zhang (UM)
Relative capacity and comparison principle

The goal is to give an elementary introduction of relative $>$ capacity and comparison principle introduced for the study of Monge-Ampère operator. Their roles in Kolodziej's study of this operator will be illustrated.

A little attention needs to be paid when considering manifolds instead of domains in complex spaces.

Topology & Geometry/Physics (Joint Seminar)
Thursday, October 9, 3:10-6:00pm
4096 EH
Stephan Stolz (Notre Dame)
Supersymmetric Euclidean field theories and generalized cohomology

This is a report of ongoing joint work with Peter Teichner (Berkeley). Elaborating Segal's axiomatic approach to conformal field theories, we define supersymmetric Euclidean field theories over a manifold X . It turns out that the set of concordance classes of such field theories over X of dimension d is in bijective correspondence to the cohomology of X (with complex coefficients) for $d=0$ and to the K -theory of X for $d=1$. We speculate that for $d=2$ we obtain the "Topological Modular Form theory" of Hopkins-Miller. Evidence is provided by our result that the partition function of a supersymmetric Euclidean field theory of dimension 2 is a weakly holomorphic integral modular form.

Differential Equations
Thursday, October 9, 4:10-5:00pm
4088 EH

Paul Kessenich (UM)

Global Existence for a 3D Incompressible Isotropic Viscoelastic Material

Global Existence for a 3D Incompressible Isotropic Viscoelastic Material ---

Incompressible viscoelastic materials can be studied using the Oldroyd-B model which views the material as an elastic polymer immersed in a Newtonian fluid. Previous global existence results for this model have used parabolic methods in which the size of the initial disturbance is inevitably dependent on the Newtonian viscosity in the Oldroyd-B equations. This talk will focus on the use of hyperbolic methods to prove global existence for these equations so that the smallness of the initial data is not restricted by the viscosity parameter.

Math Club

Thursday, October 9, 4:10-5:00pm
2nd floor Nesbitt Common Room

Amanda Knecht (UM)

The Mathematics of Sudoku

Many faculty, staff, and students at the University of Michigan spend a few minutes of their day filling in the Sudoku puzzle in the Daily. If you are a Sudoku solver, you may have stopped and wondered if there is always a solution to such a puzzle. Or maybe you asked, "If a solution exists, is it unique?", "How many numbers have to be given to you for there to be a unique solution?" or "How many Sudoku puzzles are there with a unique solution?" We will answer these and similar questions.

Theoretical Computer Science Seminar

Friday, October 10, 11:10-12:00pm
1018 DOW

Xi Chen (UM)

On the Computation and Approximation of Two-Player Nash Equilibria

On the Computation and Approximation of Two-Player Nash Equilibria Abstract: In 1950, Nash showed that every non-cooperative game has an equilibrium. Before his work, the result was known only for two-player zero-sum games. While von Neumann's minimax theorem was the mathematical foundation of the two-player zero-sum game, Brouwer's and Katutani's fixed point theorems were crucially used in Nash's proofs. His approach was later used by Arrow and Debreu in their development of the general equilibrium theory. Fourteen years after Nash's work, Lemke and Howson designed a simplex-like path-following algorithm for finding a Nash equilibrium in a general two-player game. Despite its several appealing properties, this algorithm was recently shown to have exponential worst-case complexity. In contrast, in his groundbreaking work, Khachiyan showed that the ellipsoid algorithm can solve any linear program and hence any two-player zero-sum game in polynomial time. His success, however, has not been extended to general two-player games --- no polynomial-time algorithm has yet been found for this remarkable problem. In this talk, I will present the results in characterizing the complexity of computing and approximating two-player Nash equilibria. I will also discuss the recent development in the approximation of Nash equilibria. Joint work with Xiaotie Deng.

Applied and Interdisciplinary Mathematics Seminar
Friday, October 10, 3:10-4:00pm
1084 EH
Bernard Deconinck (U of Washington)
Stability of Stationary Periodic Solutions of Nonlinear Wave Equations

The stability of solitary wave solutions of nonlinear wave equations has been extensively studied over the last few decades. Recently, there has been increasing interest in studying the stability of the periodic counterparts of these solitary wave solutions. This has been facilitated by the development of new numerical techniques, as well as an improved understanding of the analysis required to approach these questions. Some of each will be discussed in this talk.

I will discuss Hill's method, which is a numerical method to compute spectra of linear operators, and convergence results we have been able to prove for it. Then I will discuss the stability of periodic solutions of integrable equations such as the Korteweg-de Vries and nonlinear Schrödinger equations, emphasizing the complete results that may be obtained.

Student Geometry/Topology
Friday, October 10, 3:10-4:00pm
3096 EH
Daniel Kneezel (UM)
What Would You Do with a Steenrod Square?

In this third and final installment of the series on cohomology operations I will present some standard applications of Steenrod squares. We will first use the squares to give a (partial) solution to the "Hopf invariant one" problem, which will show that every division algebra over the reals must have real dimension a power of 2. The real numbers, complex numbers, quaternions, and octonions are familiar examples of real division algebras of dimensions 1, 2, 4, and 8, respectively. Time permitting, we will also consider the question of how many linearly independent tangent vector fields there can be on a sphere of given dimension by examining the action of the squares on the cohomology ring of an appropriate Stiefel manifold.

Combinatorics
Friday, October 10, 4:10-5:00pm
3866 EH
Cristian Lenart (SUNY Albany)
On combinatorial formulas for Macdonald polynomials

Macdonald polynomials (of type A) are generalizations of Schur polynomials depending on two parameters. Haglund, Haiman and Loehr [exhibited](#) a combinatorial formula for these polynomials in terms of a pair of statistics on fillings of Young diagrams. Recently, Ram and Yip [gave](#) a formula for the Macdonald polynomials of arbitrary Lie type in terms of the corresponding affine Weyl group. In this talk, I [relate](#) the above developments, by explaining how the Ram-Yip formula compresses to a new formula, which is similar to the Haglund-Haiman-Loehr one but contains considerably fewer terms; in this context, the statistics on Young diagrams mentioned above follow naturally from more general concepts. I also explain how this work extends to types B and C, where no analog of the Haglund-Haiman-Loehr formula exists. The talk is largely self-contained.