

## Roman Bezrukavnikov

### Harmonic analysis on $p$ -adic groups and $l$ -adic sheaves

I will report on a project, partly joint with D. Kazhdan and Y. Varshavsky, which introduces perverse sheaves methods into harmonic analysis on  $p$ -adic groups; this provides a partial generalization of Lusztig's character sheaves theory to the loop group case. This problem has also been addressed in a recent work by George Lusztig.

## Manjul Bhargava

### Hyperdeterminants and arithmetic

We discuss some recent applications of hyperdeterminants in arithmetic, such as to the study of number field class groups, elliptic curves, K3 surfaces, and higher-dimensional varieties.

## Matthew Emerton

### Local and global perspectives in the $p$ -adic Langlands program

In this talk I will give an overview of various developments in the  $p$ -adic Langlands program. This program studies the relationship between  $p$ -adic automorphic forms (in various senses of that concept) and  $p$ -adic Galois representations, with an emphasis on the aspects of  $p$ -adic variation that are possible on both sides of the correspondence. As with the traditional Langlands program, it has both local and global aspects. As already indicated, the global aspects are related to the theory of  $p$ -adic automorphic forms (in a general sense), while the local aspects are closely related to Fontaine's  $p$ -adic Hodge theory. The two aspects are connected in a way that is closely related to the ideas introduced by various authors (Kisin, Mazur, Taylor, Wiles, and others) in the proof of modularity theorems for Galois representations.

The talk will explore these various aspects of the program in more detail, and the relationships between them. I will aim to give some sense of the current state of the subject, but the primary focus will be on providing motivation and context.

## Dennis Gaitsgory

### Tamagawa Numbers and Nonabelian Poincare Duality, II

This will be a continuation of Jacob Lurie's talk. Let  $X$  be an algebraic curve over a finite field  $F_q$  and let  $G$  be a group scheme over  $X$ , which is generically semi-simple and simply connected. Weil's formula for the volume of the adelic quotient corresponding to  $G$  will be interpreted as a formula for the number of points over  $F_q$  of the moduli stack  $\text{Bun}(G)$  of  $G$ -bundles on  $X$ . By applying the Lefschetz trace formula, it will be shown that Weil's formula for the number of points follows from the Atiyah-Bott formula for the cohomology of  $\text{Bun}(G)$ . The Atiyah-Bott formula is a local-to-global expression for the cohomology, and we will prove it using an algebro-geometric version of non-abelian Poincare duality; specifically, by uniformizing  $\text{Bun}(G)$  by the affine Grassmannian of  $G$ .

**Alexander Goncharov**

**Geometry of canonical bases and mirror symmetry**

Given a surface  $S$  with a collection of special points on the boundary modulo isotopy, and a split reductive group  $G$ , we define a moduli space  $M(G, S)$  of  $G$ -local systems on  $S$  with some special data at the special points. We introduce a function  $W$  on  $M(G, S)$ , the potential. It determines a set of  $W$ -positive integral tropical points of  $M(G, S)$  - for  $G = SL_2$  we recover the set of Thurston's laminations on  $S$ . We show that it parametrises top components of a certain stack - surface affine Grassmannian  $Gr(G, S)$ . When  $S$  is a disc we define, using this and geometric Satake correspondence, canonical bases in various spaces arising in representation theory of the Langlands dual group, generalising Mirkovic-Vilonen bases and the work of Kamnitzer.

We conjecture a mirror duality between the Landau-Ginzburg model  $(M(G, S), W)$  and a similar one for the Langlands dual data. When  $S$  is a triangle, this recovers some work of Givental and others on mirror symmetry for flag varieties.

This is a joint work with Linhui Shen (a Yale graduate student).

**Michael Hopkins**

**$K(n)$ -local homotopy theory**

I will survey some old and recent results in  $K(n)$ -local homotopy theory with emphasis on the relationship with number theory and topological quantum field theories.

**Mikhail Khovanov**

**Categorification at roots of unity**

Upon categorification the formal parameter  $q$  from the theory of quantum groups and Hecke algebras becomes a grading shift. It is less clear how to categorify these structures when  $q$  is a root of unity. In this lecture we'll discuss essentially the only known case, when  $q$  is a prime root of unity. Working in prime characteristic and utilizing  $p$ -complexes, a generalization of the usual notion of a complex, it becomes possible to make the first steps in this categorification program and interpret defining relations in small simply-laced quantum groups (joint work with You Qi).

**Maxim Kontsevich**

**Stability and Fukaya categories**

Stability structures defined several years ago by T.Bridgeland can be considered as analogs of Kähler classes in derived noncommutative geometry, where triangulated categories replace spaces. I'll explain heuristics behind Bridgeland's axiomatics for triangulated categories arising as Fukaya categories, and propose a program mixing together stability and symplectic geometry.

**Jacob Lurie**

**Tamagawa Numbers and Nonabelian Poincare Duality, I**

Let  $q$  and  $q'$  be positive definite integral quadratic forms. We say that  $q$  and  $q'$  are in the same genus if they are equivalent modulo  $N$  for every positive integer  $N$ . Quadratic forms in the same genus need not be equivalent, but one can show that there are only finitely many equivalence classes of quadratic forms within a genus. In fact, there is an explicit formula for the number of equivalence classes of quadratic forms in the genus of a fixed quadratic form  $q$  (counted with multiplicity), called the Siegel mass formula. In this lecture, I'll review the Siegel mass formula, and explain how it was reformulated by Weil as a special case of a general conjecture about volumes of certain adelic quotients for groups over number fields. I'll then describe some recent joint work with Dennis Gaitsgory on the function field analogue of Weil's conjecture.

**Grigory Margulis**

**Homogeneous Dynamics and Geometry of Numbers**

I will talk about some interactions between homogeneous dynamics and geometry of numbers. Topics to be briefly covered include "Random Minkowski theorem" and applications to the distribution of values of quadratic forms at integral points.

**Dusa McDuff**

**Symplectic embeddings and continued fractions**

Questions concerning symplectic embeddings lie at the heart of symplectic geometry. This talk will discuss some recent progress in understanding them and some relations to questions in number theory and algebra.

**Colette Moeglin**

**On the stabilization of the spectral side of the twisted trace formula**

I will try to explain what is the Arthur-Selberg's trace formula in the twisted case, what is its stabilization and what are the problems already solved specially for the spectral side. This follows the work of Arthur and is joint work with J.-L. Waldspurger.

**Nikita Nekrasov**

**The BPS/CFT correspondence**

The BPS/CFT correspondence is a principle put forward around 2004 relating the correlation functions of chiral observables in supersymmetric gauge theories to the conformal blocks and form-factors of conformal and integrable field theories in two dimensions. In this talk I will discuss an extension of this correspondence involving holomorphic E-bundles and del Pezzo surfaces.

**Andrei Okounkov (delivered by Nikita Nekrasov)**

**Towards the index of M-theory**

M-theory in a restricted sense is a conjectural phase of string theory with eleven dimensional supergravity as its low energy approximation. We use various ideas from string dualities to develop a formalism unifying the BPS state counting in supersymmetric gauge theories and a K-theoretic version of the Donaldson-Thomas theory.

**Dmitry Orlov**

**Derived categories of coherent sheaves, geometric phantoms, and motives**

I will try to describe new phenomena and structures in the theory of derived categories of coherent sheaves, namely geometric quasi-phantom and phantom categories arising as semiorthogonal parts of surfaces of general type with  $p_g = q = 0$ .

**Peter Sarnak**

**Nodal domains of eigenmodes of the Laplacian and of random functions**

It is believed that the eigenfunctions of the quantizations of classically chaotic Hamiltonians behave like random band limited functions. We discuss this in connection with the topologies of their nodal domains and of random real projective algebraic hypersurfaces.

**Paul Seidel**

**Hidden symmetries of symplectic manifolds**

Homological mirror symmetry and other considerations have led to the realization that certain classes of non-compact symplectic manifolds have symmetries that are not realized by symplectic automorphisms, but still affect the answers to common topological questions. I will first describe these symmetries in the purely algebraic framework of Fukaya categories, and then (if I haven't run out of time) mention the geometric origin.

**Yum-Tong Siu**

**Analytic methods of constructing bundle sections and their geometric applications**

Will discuss some analytic methods of construction of sections of vector bundles which are motivated by their geometric applications to effective algebraic geometric problems such as the Fujita conjecture, hyperbolicity problems, invariance of plurigena, and the abundance conjecture.

**Eric Urban**

**On p-adic families of automorphic representations**

The theory of p-adic families of modular forms was pioneered in the eighties by the works of Hida and pursued in the nineties by those of Coleman and Mazur. In the last decade or

so, this theory has known many more developments. In this talk, I will present some of the main conjectures, results of this theory and its importance in application to number theory.

### **Akshay Venkatesh**

#### **Periods of automorphic forms**

Much of our understanding of L-functions (generalizations of the Riemann zeta function) comes from interpreting them as "periods" of modular forms – that is to say, integrals of modular forms over suitable cycles. More generally, such periods encode much interesting arithmetic information; I will discuss them and their relationship to classical questions of analytic and algebraic number theory.

### **Edward Witten**

#### **Super Riemann Surfaces Revisited**

I will recall the definition of a super Riemann surface, and the role that they play in superstring theory. I will describe recent work with R. Donagi showing that the moduli stack of super Riemann surfaces cannot be holomorphically projected to the moduli stack of ordinary Riemann surfaces. This roughly means that super Riemann surfaces cannot be described in terms of ordinary Riemann surfaces in an elementary way.