Roman Bezrukavnikov (MIT, Boston, USA)

Springer representation and coherent sheaves

Abstract: "The classical Springer action of an (affine) Weyl group on cohomology of a Springer fiber can be lifted to an action of the (affine) braid group on the derived category of coherent sheaves, which turns out to be useful in many representation theory questions. I will survey available methods to construct such an action and some of the recent generalizations."

Michel Brion (Institut Fourier, Grenoble, France)

On commutative subgroups of algebraic groups

Abstract: The objects of the talk are the closed commutative subgroups of connected reductive algebraic groups over an algebraically closed field. We will discuss the classification of these subgroups up to conjugacy (an open question in general), and its relation to the structure of homogeneous principal bundles over abelian varieties.

Dan Ciubotaru (University of Utah, Salt Lake City, USA)

Spin projective representations of Weyl groups and the Dirac operator of graded Hecke algebras

Abstract: The classification of irreducible representations of a pin double cover of Weyl groups began with Schur (1911) for the symmetric group and was completed for the other groups by Morris, Read and others about 30 years ago. Recently, motivated by the study of a Dirac operator for the graded Hecke algebras (introduced in joint work with D. Barbasch and P. Trapa), a more uniform picture for these representations emerged. I will present a new realization of these spin representations, obtained, with X. He, as a consequence of the Lusztig-Shoji algorithm for the calculation of graded Springer representations, and explain the role of spin representations in realizing L^2-models for discrete series of graded Hecke algebras, joint with E. Opdam and P. Trapa.

Arjeh Cohen (Eindhoven University of Technology, Eindhoven, the Netherlands)

Riemann surface models and regular maps

Abstract: We show how to connect regular maps effectively with models of smooth projective complex algebraic curves. The methods have been applied to all regular maps of genus at most 6 that occur in the list of Marston Conder and Peter Dobcsanyi. Also, the first Hurwitz triplet (curves of genus 14 with automorphism group PSL(2,13)) has been handled successfully; this led to the closure of an open end in the classification by Magaard and Volklein of Hurwitz groups acting transitively on the Weierstrass points of the curve. The work reported on is joint with Maxim Hendriks.

Baohua Fu (Chinese Academy of Sciences, Beijing, China)

Geometry of nilpotent orbits: generic singularities and special pieces

Abstract: I'll report a joint work with Daniel Juteau, Paul Levy and Eric Sommers, where we determined generic singularities of nilpotent orbit closures in exceptional Lie algebras. Furthermore, we will show that a transverse slice to the minimal orbit in a special piece is isomorphic to some natural finite quotient, which implies the normality of special pieces (as conjectured by Achar-Sage, which is also a consequence of a conjecture of Lusztig).

Xuhua He (The Hong Kong University of Science and Technology, Hong Kong)

Wonderful compactifications and loop groups

Abstract: Let G be a connected semisimple algebraic group of adjoint type over an algebraically closed field. In 2007, Springer introduced an interesting map from the loop group of G to the wonderful compactification of G. In this talk, I will show how to use this map to study many different topics, including unipotent varieties, affine Deligne-Lusztig varieties and local models of Shimura varieties.

Anthony Henderson (University of Sydney, Sydney, Australia)

Geometric Satake, Springer correspondence, and small representations

Abstract: Let G be a connected reductive group and W its Weyl group. Consider the functor Φ from representations of G to representations of W defined by taking the zero weight space and twisting by the sign character. This functor contains important information, but is hard to describe in general.

Note that when $G = GL_n$, the restriction of Φ to the subcategory of representations whose weights $(a_1, \cdots, a_n)$ satisfy $a_1 + \cdots + a_n = 0$ and $a_i \geq -1$ is essentially the famous Schur functor.

In particular, this restriction is of the form $\mathrm{Hom}_{GL_n}(E, -)$ where E is a tilting module that carries a commuting S_n-action.

For general G, the analogous subcategory to consider is that of small representations, and the restriction of Φ to this subcategory was studied by Broer and Reeder in the complex case. However, there is no representation analogous to E in other types. In joint work with Pramod Achar (Louisiana State University) and Simon Riche (Universite Blaise Pascal - Clermont-Ferrand II), we describe the restriction of Φ geometrically, in terms of the perverse sheaves on the affine Grassmannian of the complex dual group $G^\vee$ that correspond to small representations under geometric Satake; this makes sense for any ground ring that is Noetherian and of finite global dimension. As we show, the correct substitute for E is none other than the Springer sheaf on the nilpotent cone of $G^\vee$, with its W-action as defined by Lusztig.

Daniel Juteau (University of Caen, Caen, France)

Modular Springer representations, intersection forms and parity sheaves

Abstract: I will explain how to construct how to construct the modulo p irreducible representations of Weyl groups as the quotients of isotypical components of the top Borel-Moore homology of the Springer fibers by the radical of the intersection form modulo p, provided p is not too small. In the case of GL_n, we explain geometrically the condition of p-regularity. This is joint work with Geordie Williamson. We use the theory of parity sheaves (joint work with Carl Mautner and Geordie Williamson), and ideas from an unpublished note by Tonny Springer from 1980 called "Specht modules as subgroups of homology groups".

Wilberd Van der Kallen (Utrecht University, Utrecht, the Netherlands)

Cohomological finite generation

Abstract: View SL_2 as an algebraic group over a field k or more generally as an algebraic group scheme over a commutative noetherian ring k. Assume SL_2 acts algebraically on a finitely generated k-algebra A. Then the cohomological finite generation property (CFG) holds: The cohomology algebra $H^*(SL_2, A)$ is a finitely generated k-algebra. This result fits into a long story, going from the First Fundamental Theorem of invariant theory to strict polynomial bifunctors and good Grosshans filtrations. We will sample this story.

Syu Kato (Kyoto University, Kyoto, Japan)

A homological study of Green polynomials

Abstract: Kostka polynomials are certain family of polynomials indexed by two copies of simple modules of a Weyl group W. They are intimately connected with the (generalized) Springer correspondences, and they admits a characterization by the Lusztig-Shoji algorithm.

In this talk, we reinterpret the Lusztig-Shoji algorithm (of a complex reflection group) in terms of homological algebra. This naturally upgrades Kostka polynomials to a family of indecomposable modules that we call Kostka systems. They give a new characterization of Kostka polynomials arising from the generalized Springer correspondences in the sense of Lusztig.

Hanspeter Kraft (University of Basel, Basel, Switzerland)

The Automorphism Group of Affine n-Space

Abstract: The automorphism group of affine n-space A^n has the structure of an ind-group, also called an infinite-dimensional algebraic group. The same is true for $Aut(X)$ where X is an affine variety. Many questions and problems about group actions on A^n and on X can be formulated and understood in this language. This point of view also offers other insights and raises questions about subgroups, conjugacy classes, automorphisms, deformations, vector fields etc. We will report on recent progress about the structure of $Aut(A^n)$ and some applications.

Gus Lehrer (University of Sydney, Sydney, Australia)

The Brauer category and second fundamental theorem of invariant theory

Abstract: I shall give an explicit description of the kernel of the surjection from the Brauer algebra to endomorphisms of tensor powers of the natural representation of a classical (orthogonal or symplectic) group. The method involves a calculus of Brauer diagrams, interpreted as morphisms in the Brauer category. Quantum and modular analogues of our results can be obtained by using cellular structure. This is joint work with R.B. Zhang.

Eduard Looijenga (Utrecht University, Utrecht, the Netherlands)

Cohomological amplitude of moduli spaces of curves

Abstract: For a scheme one has a notion of cohomological excess. We first define and discuss this notion and then we state our main result which says that the universal curve of genus $g > 0$ has cohomological excess at most $g - 1$. We show that this is an algebro-geometric strengthening of Harer's theorems on the virtual cohomological dimension of the mapping class group and implies a theorem of Diaz on the maximal dimension of a complete subvariety of a moduli space of curves. We also discuss some ingredients of the proof.

George Lusztig (MIT, Boston, USA)

Springer's work on unipotent conjugacy classes and Weyl group representations

Abstract: This talk will focus on Springer's work in several areas including:
- classification of unipotent conjugacy classes;
- Springer's conjecture on Green functions as trigonometric sums;
- Springer fibres and Springer's representations of Weyl groups;
- Springer's work on exceptional representations of Weyl groups.

Ngaiming Mok (The University of Hong Kong, Hong Kong)

Recovering G/P and its distinguished subvarieties from minimal rational curves

Abstract: Fixing a polarization, a uniruled projective manifold X is covered by rational curves of minimal degree. We will restrict to the case of Picard number 1, in which case a projective manifold is uniruled if and only if it is Fano. The set of rational homogeneous manifolds $S = G/P$ of Picard number 1 (where G is a simple complex Lie group and P is a maximal parabolic subgroup of G) serves as an important class of such manifolds and as a first motivation for the development of a geometric theory based on varieties of minimal rational tangents, i.e., tangents to minimal rational curves. The latter theory, aiming in part to solve a number of classical problems in algebraic geometry, was developed in a series of works of the speaker with Jun-Muk Hwang.

In this lecture we will survey on applications of the latter theory to the study of G/P, including characterization results in terms of geometric structures and rigidity results under projective deformation in works of Hwang-Mok. We will also discuss recent results of Hong-Mok on the analytic continuation of germs of holomorphic immersions respecting geometric structures and on the characterization of certain smooth Schubert varieties of G/P.

Eric Opdam (University of Amsterdam, A msterdam, the Netherlands)

Spectral transfer maps for affine Hecke algebras

Abstract: We introduce a new kind of maps between affine Hecke algebras, which we call "spectral transfer maps". These are motivated by the role that affine Hecke algebras play in the representation theory and harmonic analysis of reductive p-adic groups (via the theory of types). These maps play a role in the local Langlands correspondence for reductive p-adic groups. We will discuss the main results on spectral transfer maps between affine Hecke algebras of unipotent types, and illustrate by examples.

Vladimir Popov (Steklov Institute of Mathematics, Moscow, Russia)

Rational functions on semisimple Lie algebras and the Gelfand–Kirillov conjecture

Abstract: The talk is aimed at describing recent solution of the rationality problem for fields of rational functions on semisimple Lie algebras and the intimately related construction of counterexamples to the Gelfand–Kirillov conjecture on the fields of fractions of universal enveloping algebras of semimple Lie algebras.

Mark Reeder (Boston College, USA)

Regular elements in Weyl groups, graded Lie algebras and p-adic groups

Abstract: I will show how Springer's theory of regular elements in Weyl groups has applications to the Geometric Invariant Theory of graded Lie algebras and thence to the representation and structure theory of reductive p-adic groups. This is joint work with B. Gross, P. Levy and J.-K. Yu.

Toshiaki Shoji (Nagoya University, Nagoya, Japan)

Character sheaves on the exotic symmetric space

Abstract: We consider the variety $X = G/H \times V$, where $G = GL(V), H = Sp(V)$ for a symplectic space V. We call X the exotic symmetric space since its "unipotent part" $X_u = (G/H)_u \times V$ is isomorphic to the exotic nilpotent cone of S. Kato. We develope the theroy of character sheaves on X, and show the Springer correspondence between H-orbits in X_u and irreducible characters of the Weyl group of H. This result was first proved by Kato, and our result gives an alternate approach based on the theroy of character sheaves.

The variety X has a natural F_q-structure with Frobenius map F. We show that the set of characteristic functions of F-stable character sheaves on X gives rise to a basis of H^F-invariant functions on X^F.

Eric Sommers (University of Massachusetts, Amherst, USA)

A duality for transverse slices between special nilpotent orbits

For the general linear group, Kraft and Procesi classified the type of the singularity of a transverse slice between two nilpotent orbits which are adjacent in the partial order on nilpotent orbits. Their result is that either the slice looks like (1) a minimal nilpotent orbit closure in the Lie algebra of a smaller general linear group, or (2) like the slice between the full nilpotent cone and the next biggest nilpotent orbit in the Lie algebra of a smaller general linear group. They then observed a remarkable duality: under the order-reversing involution on nilpotent orbits, a singularity of the first type is exchanged with a singularity of the second type (and the rank of the smaller general linear group is preserved).

In this talk I will describe a generalization of Kraft and Procesi's duality to all simple algebraic groups. This is joint work with Fu, Juteau, and Levy.

Nanhua Xi (Chinese Academy of Sciences, Beijing, China)

Module Structure on Invariant Jacobians

Abstract: We will show that a conjecture Stephen Yau on highest weights of invariant Jacobians is true for arbitrary connected semisimple algebraic groups.

Jiu-Kang Yu (Purdue University and the Chinese University of Hong Kong)

On Vinberg theory and Moy-Prasad theory

Abstract: I will discuss a connection between Kac's classification of torsion automorphisms of simple Lie algebras, and Bruhat-Tits theory. This connection then links Vinberg theory with Moy-Prasad theory and has many useful consequences in my joint work with Gross, Levy, and Reeder.

Zhiwei Yun (Stanford University, USA)

Affine Springer fibers and the rational Cherednik algebra

Abstract: I will explain how rational Cherednik algebras act on the (modified version of) cohomology of certain affine Springer fibers. Connection with Hilbert schemes and Hitchin fibrations will also be briefly mentioned. This is joint work with A. Oblomkov.