Titles and Abstracts

Tomoyuki Arakawa, Kyoto University/Ningbo University

Title: Symplectic singularities and vertex algebras

Abstract: Symplectic singularities were introduced by Beauville in the beginning of 2000's. Many of such varieties appear in representation theory as well, in particular, their quantizations are often algebras with interesting representation theory. The most famous example is the universal enveloping algebras of semisimple Lie algebras.

In this talk, I will explain that the "chiral" quantizations of symplectic singularities also appear in connection with 4 dimensional N=2 supercomformal field theories in physics.

Kei Yuen Chan, The University of Hong Kong

Title: An analogue of Bernstein-Zelevinsky layers for $\mathrm{GL}_n(\mathbb{C})$ and branching laws

Abstract: Building on works of Arakawa-Suzuki and Ciubotaru-Trapa, we construct an exact functor from the category of $(\mathfrak{g}, K)$-modules of $\mathrm{GL}_n(\mathbb{C})$ to the category of finite-dimensional modules of graded Hecke algebras of type A. We shall explain how to use this functor to obtain an analogue of Bernstein-Zelevinsky layers - a key tool in the representation theory of p-adic general linear groups - for $\mathrm{GL}_n(\mathbb{C})$. I shall discuss some work in progress on applications of the functor on branching laws such as the non-tempered Gan-Gross-Prasad problems. This is based on a joint work with Daniel Kayue Wong.

Dougal Davis, University of Melbourne

Title: Unitary representations of real groups and localisation theory for Hodge modules

Abstract: In a seminal paper from 2011, Kari Vilonen and Wilfried Schmid proposed that the deep theory of mixed Hodge modules can be applied to the old problem of determining the unitary representations of a real reductive Lie group. They conjectured that the unitarity of a representation is completely determined by a canonical filtration, the Hodge filtration, coming from the geometry of the complex flag variety. I will explain a recent paper with Vilonen in which we prove this expectation, along with other remarkable properties of the Hodge filtration. In honour of the occasion, I will focus especially on the great debt our work owes to Schmid's many contributions to both representation theory and Hodge theory.

Xuhua He, The University of Hong Kong

Title: Towards a Geometric Theory of Characters

Abstract: In the field of representation theory, understanding the behavior of characters has long been a central pursuit. Characters are fundamental objects that encode crucial information about the symmetries inherent in mathematical structures. In

this talk, we embark on an exciting journey towards a geometric theory of characters, a captivating framework that reveals hidden connections between algebraic geometry, combinatorics, and the vast landscape of representation theory.

We will begin by exploring the original algebraic definition of characters, focusing on their significance in groups and group algebras. From there, we will delve into Lusztig's theory of character sheaves on $GL_n(\bar{F}_q)$, which serves as a geometric counterpart to characters of the finite group $GL_n(F_q)$. This geometric perspective unveils remarkable connections between algebraic geometry of algebraic groups and their flag variety and the study of characters of finite groups of Lie type. In the end, we will embark on an ongoing project aimed at extending the theory of character sheaves to loop groups.

Joachim Krieger, EPFL

Title: Lie group actions and dispersive PDE

Abstract: I will survey some recent developments in the theory of dispersive PDE, particularly relating to existence of large global solutions as well as singularity formation, and the role that Lie group actions have played therein. Work by myself together with my co-authors S. Miao, W. Schlag, D. Tataru in particular will be touched upon.

Bong Lian, Brandeis University, BIMSA, SIMIS

Title: Fractional Complete Intersections

Abstract: We will consider a class of (typically) singular Calabi-Yau varieties given by cyclic branched covers of a fixed semi-Fano manifold. The first prototype example goes back to Euler, Gauss and Legendre, who considered 2-fold covers of $\mathbb{P}^1$ branched over 4 points. Two-fold covers of $\mathbb{P}^2$ branched over 6 lines have been studied more recently by many authors, including Matsumoto, Sasaki, Yoshida and others, mainly from the viewpoint of their moduli spaces and their comparisons. I will outline a higher dimensional generalization from the viewpoint of mirror symmetry, and discuss the Riemann-Hilbert problem for periods of these singular varieties. The new insight here is the idea of 'abelian gauge fixing' and 'fractional complete intersections' that leads to a new interpretation of those classical results. The idea further points to a construction of large class of Calabi-Yau mirror pairs. The lecture is based on joint work with S. Hosono, T.-J. Lee, M. Romo, L. Santilli, H. Takagi, S.-T. Yau.

Lucas Mason-Brown, University of Oxford

Title: Unipotent representations are unitary

Abstract: Let $\Pi(G)$ denote the set of irreducible unitary representations of a semisimple Lie group G. A fundamental problem in representation theory is to describe the structure of this set. In previous joint work with Losev and Matvieievskyi, we have defined a class of representations called *rigid unipotent*, which are conjectured to form the building blocks of $\Pi(G)$. Unfortunately, it is not at all clear from their construction that these representations are unitary. In this talk, I will sketch a proof of unitarity. The proof I will present is an application of the program, initiated by

Schmid and Vilonen, for studying unitary representations via mixed Hodge modules. This is joint work in progress with Dougal Davis.

Stephen D. Miller, Rutgers University

Title: Wilfried Schmid's vision of automorphic distributions

Abstract: in the late-1990s Wilfried Schmid showed how boundary value distributions of automorphic forms could be used to prove new results in analytic number theory. His ideas, in particular to apply representation-theoretic tools such as Mackey theory, gave rise to new sources of information about sums of coefficients of automorphic forms, most notably the Voronoi summation formula for $SL(3, Z)$. They also simplify many other aspects of the theory of automorphic forms. I'll describe joint work with Schmid which, in light of the recent Ph.D. thesis of Doyon Kim, now gives an algebraic-geometric proof of the existence and uniqueness of Whittaker functions for $SL(n, R)$.

Henri Moscovici, Ohio State University

Title: Prolate wave operators, Sonin spaces and the zeros of Zeta

Abstract: I will talk about two recent developments relating the classical prolate spheroidal operator to the zeros of the Riemann zeta. One of them, which is joint work with A. Connes, uncovers a previously unexplored negative spectrum of a specific selfadjoint extension of the prolate wave operator, concentrated in the associated Sonin space, which has a similar ultraviolet behavior as the zeros of zeta. The other, which is joint work with A. Connes and C. Consani, provides a formalism which allows to extend the prolate wave operator and the Sonin space from the archimedean place to the adelic level of Connes' semilocal trace formula. The latter involves the metaplectic representation of $Mp(2, R)$.

Sian Nie, Chinese Academy of Science

Title: Steinberg's cross-sections and loop Deligne-Lusztig varieties

Abstract: Loop Deligne-Lusztig varieties (LDLVs for short) were first introduced by Lusztig, whose cohomology are expected to realize interesting reprentations of p-adic groups. For general linear groups, by studing LDLVs of Coxeter type, Boyarchenko, Weinstein, Chan and Ivanov obtained a purely local and geometric realization for a large class of local Langlands and Jaquet-Langlands correspondences. In this talk, we will discuss a generalization of their results to other reductive groups. This is a joint work with Ivanov and Tan. A key ingredient is a loop group version of Steinberg's cross-sections.

Boris Shapiro, Stockholm University

Title: On the Waring problem for polynomial rings

Abstract: I will show that a generic complex-valued form of degree kd in $n + 1$ variables can be represented as a sum of at most k^n k-th powers of forms of degree d. Several related conjectures will be formulated.

Carlos Simpson, CNRS, Université Côte d'Azur

Title: A nonabelian Hodge viewpoint on Hecke eigensheaves in the geometric Langlands program

Abstract: The Donagi-Pantev program aims to give a description, in terms of parabolic logarithmic Higgs bundles, of the Hecke eigensheaves that come out of the geometric Langlands program. We recall that a representation Λ of the fundamental group of a Riemann surface X, serving as the "eigenvalue", leads to a Hecke eigensheaf on the moduli stack Bun of bundles on X. This perverse sheaf involves a representation of the fundamental group of a Zariski open subset of Bun, the complement of the "wobbly locus". It is a natural question to look for a geometric understanding of this representation. Following the "electro-magnetic duality" of Kapustin and Witten, and based on their analysis of the classical limit of geometric Langlands, Donagi and Pantev initiated a conjectural program of analyzing this question using the nonabelian Hodge correspondence. One of the main features is that the spectral variety of the parabolic Higgs bundle over Bun is identified with the fiber of the Hitchin fibration corresponding to Λ, under the birational equivalence $T^*Bun \sim \mathcal{M}_{Higgs}$. Donagi and Pantev treated the case of the projective line minus 5 points. In our current work, we treat the case of rank 2 local systems on a curve of genus 2, using the classical Narasimhan-Ramanan description of Bun.

This is joint work with Ron Donagi and Tony Pantev

Jorge A.,Vargas, CIEM-FAMAF, Universidad Nacional de Córdoba

Title: A duality in branching laws for Discrete Series

Abstract: Let $(G, H := (G^\sigma)_0)$ be a reductive symmetric pair, and let (π, V) denote a *H-admissible* square integrable representation for G. We fix a maximal compact subgroup $K := G^\theta$ of G so that $L := H \cap K$ is a maximal compact subgroup of H. Let $H_0 = (G^{\sigma\theta})_0$ denote the dual subgroup to H. The aim of the exposition is to present the duality formula

$$Hom_H(Y, V_{|_H}) \equiv Hom_L\big(Z, \mathbb{H}^2(H_0, \tau)\big).$$

Here, (ρ, Y) is a Discrete Series for H. $(\sigma, Z), Z \subset Y$ is the lowest L-type of (ρ, Y). Let $(\tau, W), W \subset V$ denote the lowest K-type of (π, V). We write $res_L(\tau) = \oplus_i(\sigma_i, Z_i)$ as sum of L-irreducibles. We can show for each σ_i there exists a Discrete Series $H^2(H_0, \sigma_i)$ for H_0 of lowest L-type (σ_i, Z_i). We define $\mathbb{H}^2(H_0, \tau) := \oplus_i H^2(H_0, \sigma_i)$.

The duality formula, in case $H/L \hookrightarrow G/K$ is a holomorphic imbedding has been shown by Kobayashi-Pevzner-Nakahama. We will sketch a new proof of their result as well as the main ingredients and steps for the general case. The proof of the duality formula is based on work of Atiyah-Schmid, W. Schmid, Hecht-Schmid, T. Kobayshi, Duflo-Heckmann-Vergne. This is joint work with Bent Ørsted in Aarhus, Denmark.

Bin Xu, YMSC, Tsinghua University

Title: Unipotent A-packets for real symplectic and even orthogonal groups

Abstract: The special unipotent representations of real classical groups have been classified recently by Barbasch-Ma-Sun-Zhu in a series of works. In this talk we will

explain how to obtain the A-packets of these representations in the case of symplectic and even orthogonal groups. This is a joint work with Taiwang Deng, Chang Huang and Binyong Sun.