Discussion Meeting on
ANALYTIC & ALGEBRAIC GEOMETRY
24-28 March, 2014

At KERALA SCHOOL OF MATHEMATICS, KOZHIKODE, KERALA

Speakers:

Joergen Ellegaard Andersen

Henning Haahr Andersen

Professor Sergey Arkhipov

Professor Jean-Baptiste Meilhan

Daniel Tubbenhauer

Niels Leth Gammelgaard

Florian Schätz

Søren Fuglede Jørgensen

Jens Kristian Egsgaard

Nitin Nitsure

D.S. Nagaraj

Sukhendu Mehrotra

Chanchal Kumar.

Amit Hogadi

Arijith Dey

V. Balaji

Title & Abstracts

HENNING HAAR ANDERSEN

TITLE: REPRESENTATION THEORY FOR QUANTUM GROUPS RELATED TO TQFT

ABSTRACT: There are still a huge number of open questions in the representation theory for quantum groups. In particular, when the quantum parameter is a root of unity, nite dimensional modules are no longer semisimple and it is typically a hard probelm to nd composition factors and indecomposable summands of a given module.

In this talk we shall consider the following challenge: Let q be acomplex root of unity and consider the quantum group Uq = Uq(g) corresponding to a nite dimensional Lie algebra g. Suppose V is your favorite representation of Uq. Describe the structure of the endomorphism algebras $End_{U_q_ (V^{\otimes r})$. We shall show that even in the case when g = sl2 and V is an irreducible module of dimension more than 2 this is no easy task.
The progress reported on in this talk is joint work with G. Lehrer and R. Zhang.

JEAN -BAPTISTE MEILHAN

TITLE: Milnor Invariants and the HOMFLYPT polynomial

ABSTRACT: The purpose of this talk is to present, to a nonexpert audience, a formula relating two link invariants of rather different nature : on one hand, Milnor invariants are extracted from the lower central series of the fundamental group of the exterior ; on the other hand,
the HOMFLYPT polynomial is a quantum invariant. After reviewing the definitions, we will show how Milnor invariants of a link in the 3-sphere can be represented as a combination of HOMFLYPT polynomial of knots obtained from the link by various band sum operations. We shall also review the theory of finite type invariants of knots and links, which is a key tool in proving this result.
This is a joint work with A. Yasuhara.

JENS KRISTIAN EGSGAARD

TITLE:

ABSTRACT: The Temperley-Lieb algebra have a family of representations indexed by Young diagrams with two rows. Each of these representations depend on a parameter q, and can be used to construct representations of the braid group. These new representations allow us to define the Jones polynomial of a link. The braid group can be thought of as the
mapping class group of a disc with marked points, and we will show how to relate these representations, when $q=-1$, with the action of the braid group on the homology of a double cover of the disc, ramified over these marked points.

FLORIAN SCHATZ

TITLE: Homotopy quantum field theories and flat connections

ABSTRACT: Homotopy quantum field theories (HQFTs) can be thought of as a functorial approach to topological sigma models. They were introduced by Turaev as a slight extension of the notion of topological quantum field theories (TQFTs). After motivating the functorial approach to quantum field theories in general, I will focus on theories with topological flavor. In particular, I will explain why all TQFTs in dimension d=1 are trivial, while the category of HQFTs with target X coincides

with the category of flat vector bundles over X. I will then provide several evidences that flat superconnections over X yield HQFTs with target X in arbitrary dimensions. In the final part, I will outline one potential approach to a general construction. This is ongoing joint work with Camilo Arias Abad (Max-Planck Institute of Mathematics, Bonn).

DANIEL TUBBENHAUER

TITLE: CATEGORIFICATION: AN INTRODUCTION TO sln-LINK HOMOLOGIES

ABSTRACT: The notion categorification originated in work of Crane and Frenkel on algebraic structures in TQFT's, but it has become increasingly clear that it is a broad mathematical phenomenon with applications extending beyond these original motivations. It is a huge business nowadays. We only focus on one particular part of it: Categorification from the viewpoint of topology. For the purpose of the talk this just means categorification of the sln-link polynomials focussing on the case n = 2 and its combinatorics.

The Jones polynomial is a celebrated invariant of links. It is also called sl2-polynomial, because one can use representation theory of Uq(sl2) to obtain it. It has sln variants using the representation theory of Uq(sln) instead. Moreover, all of them have categorifications called the Khovanov-Rozansky sln-homologies. These are certain chain complexes of graded vector spaces whose graded Euler characteristic gives the sln-polynomials.

We will explain the n = 2 case in detail, i.e. we will explain how Khovanov homology "categorifies" the Jones polynomial. We will introduce the Khovanov homology combinatorial and only sketch its deep relation to "higher" representation theory of Uq(sl2).

JOERGEN ELLEGAARD ANDERSEN

TITLE: Quantum representations of mapping class groups and applications.

ABSTRACT: We will describe the gauge theory construction of the quantum representations of the mapping class groups using the geometric quantization of the moduli space flat connections. We will then discuss how this geometric construction can be used to establish properties of these representations and properties of the mapping class group.

SERGEY ARKHIPOV

TITLE: From the Demazure Descent Data to braid group actions on categories.

ABSTRACT: The goal of the talk is to propose a framework for passing from Demazure type functors to braid group actions on a category.

We start from recalling the classical notion of the Drinfeld center for a monoidal category. We discuss a natural setup for a functor between monoidal categories to have an upgrading to a functor between the corresponding Drinfeld centers.

Then we introduce the central geometric example: for an algebraic variety X acted by a reductive group G, we consider the monoidal category of quasicoherent sheaves on X equivariant with respect to the Borel subgroup G. We describe the derived Drinfeld center of the category in terms of certain equivariant matrix factorizations.

We demonstrate that in the example, the degenerate Hecke algebra acts on the former category by Demazure functors, and a similar construction for the latter category gives rise to a categorical Braid group action.

Finally, we formulate our conjecture: given a monoidal triangulated category C, a choice of Demazure Descent Data on C leads to a categorical braid group action on the derived Drinfeld center of C.

NIELS LETH GAMMELGAARD

TITLE: Combinatorics of Deformation Quantization on Kähler Manifolds

ABSTRACT: Quantization usually seeks to represent classical observables, in the form of functions on a symplectic manifold of classical states, as operators on a Hilbert space of quantum states. Sidestepping the operator representation, deformation quantization encodes the non-commutative behaviour of quantum observables through a deformation, called a star product, of the usual point-wise product in the Poisson algebra of functions on the symplectic manifold. A particular quantization procedure is often facilitated by a polarization on the symplectic manifold, and deformation quantization is no exception. In the presence of a compatible complex structure on the symplectic manifold, all star products, respecting the complex structure, can be completely classified by their Karabegov form. In this talk, we will see how to recover a completely explicit formula for any star product from its Karabegov form. The formula uses combinatorial graphs to encode differential operators in local coordinates, and the proof relies purely on combinatorial manipulations of the graphs.

SOREN FUGLEDE JORGENSEN

TITLE: The AMU conjecture for punctured spheres

ABSTRACT: The ``quantum representations'' are (projective) representations of the mapping class groups of surfaces -- parametrized by a natural number k called the level -- that play a central role in 3-dimensional topological quantum field theory.

In this talk, we discuss a conjecture by Andersen, Masbaum, and Ueno stating that for all large enough k, the level k quantum representation of a given pseudo-Anosov mapping class has infinite order; this may be seen as saying that the quantum representations are sensitive to the dynamics of the mapping classes they represent. We will prove this conjecture for a large family of pseudo-Anosov mapping classes of punctured spheres by building upon the results of Egsgaard's talk.

NITIN NITSURE

TITLE: Cohomology of algebraic atacks, and application to quadric invariants.

ABSTRACT: A cohomology theory for finite and l-adic coefficients has recently been developed for algebraic stacks by Behrend, Laszlo, Olsson, etc. I will give an exposition of this theory, and indicate application to quadric invariants (joint work with Saurav Bhaumik).

D.S. NAGARAJ

TITLE: Image of P^2 in Grassmainan under a globally generated vector bundle

ABSTRACT: If E is rank two vector bundle on a variety X generated by sections then we get morphism from X to a suitable Grassmanian. In this talk we discuss the case some special of rank of 2 vector bundle on P^2.

SUKHENDU MEHROTRA

TITLE: Generalized K3 surfaces via deformations of Hilbert schemes

ABSTRACT: Let X be complex K3 surface, and X[n] the Hilbert scheme of n (>1) points on X. It was shown by Beauville that this is a holomorphic symplectic manifold which deforms in a 21 dimensional family. Since the deformation space of X is 20 dimensional, the generic deformation of X[n] is not a Hilbert scheme. We present a construction whereby these extra deformation may be interpreted as arising from "generalized K3 surfaces": to any general deformation M of X[n], we associate a K3 triangulated category D(M)^L, such that when M is the Hilbert scheme Y[n], D^(M)^L coincides with the derived category of Y. This is joint work with Eyal Markman.

CHANCHAL KUMAR

TITLE: Betti numbers of certain monomial ideals.

ABSTRACT: We consider some combinatorially interesting monomial ideals and compute their multigraded Betti numbers. Betti numbers of Alexander duals of these ideals are also investigated.

AMIT HOGADI

TITLE: Fundamental group of varieties with quotient singularities

ABSTRACT: In this talk I will discuss recent joint work with Indranil Biswas which shows that the fundamental group of a variety with quotient singularities over any field k, coincides with that of its desingularisation. This is a generalization of a result by Koll\'ar in characteristic zero.

ARIJITH DEY

TITLE: Gieseker-Uhlenbeck morphism for parabolic moduli spaces over algebraic surface.

ABSTRACT: We generalize the work of Baranovsky and prove that Gieseker-Uhlenbeck morphism for parabolic moduli over surface to be strictly semismall under suitable stratification. As an application we could compare the Poincare polynomial of both these spaces. This is a joint work with R. Parthasarathy.

V. BALAJI

TITLE: Degenerations of moduli spaces of Hitchin pairs

ABSTRACT: In this talk I will discuss some recent results of mine with Nagaraj-Barik on Degenerations of the moduli space of Hitchin pairs. This leads to some new compactifications of Picard varieties of stable curves different from the ones studied by Oda-Seshadri or Caporaso.
