Short Presentations: Titles & Abstracts

Iana Anguelova *University of Illinois, Urbana-Champaign*
"Quantum Vertex Algebras"

On the basis of Borcherds definition of an (A, H, S) quantum vertex algebra we propose a generalization of the notion of quantum fields. We discuss examples, in particular the Frenkel-Reshetikhin example of a deformed chiral algebra, and an example of a quantum vertex algebra satisfying both Frenkel-Reshetikhin and Kazhdan-Etingof definitions of a quantum vertex algebra.

Katrina Barron *University of Notre Dame*
"Deformations of the $N = 2$ Neveu-Schwarz algebra and even and odd spectral flow on the worldsheet geometry of $N = 2$ superconformal field theory"

A realization of the even and odd spectral flow on the worldsheet geometery of propagating superstrings for $N = 2$ superconformal field theory is given via a deformation of the infinitesimal superconformal local coordinates which give a representation of the $N = 2$ Neveu-Schwarz algebra. Specializing the parameter of the odd spectral flow gives the mirror map. Consequences for $N = 2$ Neveu-Schwarz vertex operator superalgebras are given using the correspondence between the worldsheet geometry and the algebra of correlation functions governed by these worldsheets.

Karin Baur *University of California, San Diego*
"Admissible characters in the sense of Lynch"

Parabolic subalgebras $\mathfrak{p}$ of semisimple Lie algebras define a $\mathbb{Z}$-grading of the Lie algebra. If there exists a nilpotent element in the first graded part of $\mathfrak{g}$ on which the adjoint group of $\mathfrak{p}$ acts with a dense orbit, the parabolic subalgebra is said to be nice. The corresponding nilpotent element is also called admissible. Nice parabolic subalgebras of simple Lie algebras have been classified. In the case of Borel subalgebras a Richardson element of $\mathfrak{g}_1$ is exactly one that involves all simple root spaces. It is however difficult to write down such nilpotent elements for general parabolic subalgebras. We give an explicit construction of admissible elements in $\mathfrak{g}_1$ that uses as few root spaces as possible.

Maarten Bergvelt *University of Illinois, Urbana-Champaign*
"H_T-vertex algebras and the infinite Toda lattice"

Let $H_T = \mathbb{C}[T, T^{-1}]$ be the Hopf algebra of symmetries of a lattice of rank 1, or equivalently H_T is the group algebra of a free Abelian group with one generator T. We construct conformal algebras, vertex Poisson algebras and vertex algebras with H_T as symmetry. For example, the Hamiltonian structure for the infinite Toda lattice gives rise to an H_T-vertex Poisson structure on a free difference algebra. Examples of H_T-vertex algebras are constructed from representations of a class of infinite dimensional Lie algebras related to H_T in the same way loop algebras are related to the Hopf algebra $H_D = \mathbb{C}[D]$ of infinitesimal translations used in the usual vertex algebras.

Corina Calinescu *Rutgers University*
"Principal subspaces of representations of affine Lie algebras and vertex operator algebras"

Recently, S. Capparelli, J. Lepowsky and A. Milas initiated a new approach of getting recursions. An important role in this work is played by the principal subspaces of the standard $\widehat{\mathfrak{sl}}(2)$-modules.

In this talk we discuss the presentation of the principal subspaces of the standard $\widehat{\mathfrak{sl}}(3)$-modules. As a consequence of this result and vertex operator algebra techniques we obtain recursions. Then, by solving them, we recover the graded dimensions of the principal subspaces.

Joerg Feldvoss *University of South Alabama*
"Existence of triangular Lie bialgebra structures"

In this talk we completely characterize those finite-dimensional Lie algebras over arbitrary fields of characteristic zero or over algebraically closed fields of arbitrary characteristic which admit a non-trivial (quasi-)triangular Lie bialgebra structure. As a consequence we extend the main result of Vivian de Smedt (Lett. Math. Phys. 31 (1994), 225-231) from the real or complex numbers to arbitrary fields of characteristic zero or algebraically closed fields of arbitrary characteristic. We will also discuss the related question of the existence of non-trivial solutions of the classical Yang-Baxter equation.

Avital Frumkin *Tel Aviv University, Israel*
"A probability approach to Klyachko theorem"

I shall give a pure represantation theory explanation and computation of the probability that the equation $A+B=C$ holds when A, B, C are hermitian matrices with given spectrum each.

Dimitar Grantcharov *San Jose State University*
"On the automorphisms of Kac-Moody Lie supealgebras"

In a recent joint work with A. Pianzola we described the structure of the algebraic group of automorphisms of all simple finite dimensional Lie superalgebras $\mathfrak{g}$. Using this classification we will provide a precise description of the automorphism group of $\mathfrak{g} \otimes_k R$ under certain assumptions on the ring R. The case of $R = k[t, t^{-1}]$ is of particular interest as it is a part of the Kac-Moody theory.

Ayumu Hoshino *Sophia University, Japan*
"Polyhedral realizations of crystal bases for modified quantum algebras of arbitrary rank 2 cases"

Modified quantum algebra is an algebra obtained by modifying the Cartan subalgebra of the quantum algebra. In general, this algebra has a crystal base which may not contain a highest weight nor a lowest weight components. In my talk, we describe the crystal bases of the modified quantum algebras and give the explicit form of the highest (or lowest) weight vector of its connected component $B_0(\lambda)$ containing the unit element for arbitrary rank 2 cases. We also present the explicit form of $B_0(\lambda)$ cotaining the highest (or lowest) weight vector by the polyhedral realization method.

Keith Hubbard *University of Notre Dame*
"Vertex operator coalgebras and their relations to VOAs"

The notion of vertex operator coalgebra will be presented and motivated via the geometry of conformal field theory. Vertex operator coalgebras are fundamentally related to VOAs in multiple ways and may lead to greater understanding of the module theory of VOAs (via vertex tensor categories). The talk will focus on both of these subjects.

Dijana Jakelic *University of Virginia*
"Branched crystals and the category $\mathcal{O}$"

(This is joint work with V. Chari and A. Moura.) We describe a theory of (branched) crystals which is adapted to the study of representations in the Bernstein-Gelfand-Gelfand category $\mathcal{O}$ and which generalizes the theory of normal crystals of Kashiwara. In the case of $\mathfrak{sl}_2$ we show that one can associate (uniquely up to isomorphism) to every module in $\mathcal{O}$ a branched crystal. We show that the indecomposable modules in $\mathcal{O}$ correspond to "indecomposable" branched crystals. We also define the tensor product of these crystals and show that the indecomposable components of the tensor product of branched crystals are the same as the crystals associated to the indecomposable summands of the tensor product of the corresponding modules.

Apoorva Khare *University of Chicago*
"The BGG category $\mathcal{O}$ over a skew group ring"

We explore the category $\mathcal{O}$ over the smash product of a finite group and a "regular triangular algebra" (examples of this latter abound in the literature). Assuming what we call "Condition (S)" holds, the category $\mathcal{O}$ splits as a direct sum of blocks, each a highest weight category (with enough projectives and BGG reciprocity). We relate the category $\mathcal{O}$ over a tensor product of such skew group rings, to the individual categories $\mathcal{O}_i$.

Stefan Kolb *Virginia Polytech Institute and State University*
"Quantum symmetric pairs and the reflection equation"

Quantum symmetric pairs, i.e. quantum group analogues of $U(\mathfrak{g}^\theta)$ for symmetric semisimple lie algebras $(\mathfrak{g}, \theta)$ have been constructed by M. Noumi, T. Sugitani, and M.Dijkhuizen using explicit solutions of the reflection equation. Over the last years G. Letzter has developped a general theory of qunatum symmetric pairs as one sided coideal subalgebras of $U_q(\mathfrak{g})$. In the present talk the relation between the two approaches is discussed. It is shown, how central elements in Letzter's coideal subalgebras lead to solutions of the reflection equation which can be used for a Noumi-Sugitani-Dijkhuizen type construction.

Michael Lau *University of Ottawa, Canada*
"Bosonic and fermionic representations"

Various Lie algebras have natural actions on highest weight modules for Weyl and Clifford algebras. These are called bosonic and fermionic representations. For affine Lie algebras, these include the vertex operator representations, as well as the oscillator/spinor modules. In this talk, I will describe a very general method for constructing such representations in a uniform manner. The idea is based on a paper of A. Feingold and I.B. Frenkel (1985) for affine Lie algebras, and generalizes the results obtained by Y. Gao (2002) for some extended affine Lie algebras.

Yiqiang Li *Kansas State University*
"A description of affine canonical bases"

We generalize Lusztig's description of the affine canonical bases elments to the arbitrary orientations of the underlying affine quivers.

Antun Milas *State University of New York, Albany*
"Number theoretic properties of Andrews-Gordon series"

For every $k \geq 2$ we consider arithmetic properties of certain holomorphic modular forms attached to normalized Andrews-Gordon series $\mod 2k+1$. We completely determined the vanishing of such modular forms and show that nonzero modular forms classify supersingular elliptic curves in characteristic p.

My talk will be largely a report on a joint work with Ken Ono and Eric Mortenson.

Adriano Moura *University of California, Riverside*
"q-characters of fundamental representations of quantum affine algebras"

The notion of q-characters for finite-dimensional representations of Quantum Affine Algebras was introduced by E. Frenkel and N. Reshetikhin as the analogue of the usual formal characters. Seven years after, general character formulas are still unknown. Using some geometric constructions Nakajima obtained formulas in terms of tableaux for some class of representations. A missing part of the puzzle is a deeper understanding of the role of the Braid Group in this theory. In this talk based on a joint work with V. Chari, we present a first result in this direction and then use it to present closed formulas for the q-characters of the fundamental representations in terms of very simple combinatorial objects.

David Nacin *Rutgers University*
"Partially commuting algebras and their connections to Q_n"

I will discuss techiques involving partially commuting algebras which reveal information about quotients of the Algebras Q_n studied by Gelfand, Retakh and Wilson.

Erhard Neher *University of Ottawa, Canada*
"Central extensions of Lie tori"

Extended affine Lie algebras are generalizations of affine and of toroidal Lie algebras. Recent results of the speaker show that the structure of an extended affine Lie algebra is analogous to the structure of an affine Kac-Moody algebra if one replaces the loop algebra by a centreless Lie torus: All extended affine Lie algebras are obtained by taking a central extension of a centreless Lie torus and then adding some derivations (and a suitable 2-cocyle, which is not present in the situation of affine Kac-Moody algebras). In this talk, I will concentrate on the Lie torus ingredient of this construction and describe the universal central extension of a Lie torus.

Deepak Parashar *University of Wales Swansea, UK*
"Coloured Yang-Baxter operators"

For any algebra two families of coloured Yang-Baxter operators are constructed, thus producing solutions to the two-parameter quantum Yang-Baxter equation. We compute the matrix forms of these operators for two and three dimensional algebras and present a FRT bialgebra for one of these families. Solutions for the one-parameter quantum Yang-Baxter equation are derived and a Yang-Baxter system constructed.

Alexander Retakh *Massachusetts Institute of Technology*
"Modular conformal algebras"

We define conformal algebras in positive characteristic. The goal is to provide evidence for certain conjectures about subalgebras of $\mathfrak{gl}_\infty$.

Natasha Rozhkovskaya *University of Wisconsin, Madison*
"Central elements of the universal enveloping algebra of $\mathfrak{gl}(n, \mathbb{C})$ and Yangians"

There are some interesting central elements in the universal enveloping algebra which can be viewed as non-commutative analogs of determinants. We discuss these analogs and connection to the Yangian of $\mathfrak{gl}(n, \mathbb{C})$.

Eric Rowell *Indiana University*
"Modular tensor categories: towards classification"

Modular tensor categories (MTCs) arise as representation categories of quantum groups, VOAs and quotients of the braid group algebra. They may be viewed as the algebraic underpinnings of topological quantum field theory and, as such, the "software" of the topological model for a quantum computer as proposed by Freedman and Kitaev. I will discuss properties of MTCs and progress towards a classification conjecture. This is joint research with Zhenghan Wang and others.

Alistair Savage *Fields Institute and University of Toronto, Canada*
"Branching rules and quiver varieties"

We will discuss how one can use the geometric methods of quiver varieties to explore the branching rules of Kac-Moody algebras. In type A, we can recover the usual branching rules by examining flag varieties. In other types, we find a new way to handle the fact that the branching is, in general, not multiplicity free. We see that the geometry presents us with a natural way to split the restricted representation up into irreducible pieces.

Shirlei Serconek *Federal University of Goias, Brasil*
"Distributivity of lattices of defining relations"

Consider a graded subspace I of the tensor algebra $T(V)$ and the algebra $T(V)/\langle I\rangle$ .There is a naturally associated lattice of subspaces $V^i I V^l$. A natural question is: Is this lattice distributive?

Bin Shu *University of Virginia*
"Cartan invariants and blocks for Zassenhaus algebras"

In this talk, we study the Cartan invariants and blocks for rank-one Cartan type Lie algebra $W(1,n)$. This is done by reducing representations of generalized restricted Cartan type Lie algebra $W(1,n)$ to representations of restricted Lie algebras $W(1,1)$ and of $\mathfrak{sl}(2)$, and then extending Feldvoss-Nakano's argument on $W(1,1)$ to the case $W(1,n)$. Our discussion also shows some surprising difference between the representations of the restricted Lie algebra $W(1,1)$ and the non-restricted Lie algebra $W(1,n)$ $(n>1)$, when the character heights of representations are zero.

David Taylor *University of Virginia*
"Trace functions of integrable modules over classical subalgebras of $\widehat{\mathfrak{gl}}_\infty$"

In the late 90's, Bloch and Okounkov introduced and calculated a certain n-point correlation function on integrable $\widehat{\mathfrak{gl}}_\infty$-modules of level 1. Cheng and Wang extended this result in giving an explicit formula for the n-point correlation function of any arbitrary integrable high weight module of $\widehat{\mathfrak{gl}}_\infty$. Here we introduce and establish formulas for arbitrary integrable high weight modules of a particular subalgebra of $\widehat{\mathfrak{gl}}_\infty$, using Fock space realiziations and Howe duality.

Imre Tuba *Virginia Tech*
"Reconstructing braided semisimple tensor categories"

Tensor categories are at the center of modern formulations of quantum mechanics. Of particular interest are semisimple braided tensor categories, where the braiding encodes nontrivial symmetries of the physical system. Unfortunately, very little structure theory is known about such categories.

In the special case that the tensor product rules mimic those of finite dimensional representations of type A quantum groups, David Kazhdan and Hans Wenzl developed a technique to reconstruct the categorical structure from underlying combinatorial data. They proved that under suitable conditions such tensor categories are equivalent to the representation category of the corresponding quantum group (or its semisimple quotient) up to a twist of the tensor product. I will briefly present a generalization of this reconstruction technique to braided tensor categories of type BCD and show how the full tensor structure and the morphisms can be recovered by comparing idempotents in the endomorphism rings and in BMW-algebras. These results are joint work with Wenzl.

Tensor categories also appear in low-dimensional topology and the representation theory of Lie algebras, quantum groups, loop groups, and Kac-Moody algebras.