Tomoyuki Arakawa (RIMS)

Title: Chiral algebras of class S and Moore-Tachikawa symplectic varieties

Abstract: Recently, Braverman, Finkelberg and Nakajima have constructed a new family of the (possibly singular) symplectic varieties called the Moore-Tachikawa symplectic varieties. We upgrade this construction to the setting of vertex algebras. This not only gives a functorial construction of the genus zero chiral algebras of class $S$, that is, the vertex algebras corresponding to the theory of class $S$ in $4d N = 2$ SCFTs via the $4d/2d$ duality, but also proves a conjecture in physics on the relation between the Higgs branches of $4d N = 2$ SCFTs and the corresponding vertex algebras for the theory of class $S$.

Huanchen Bao (University of Maryland)

Title: Canonical bases arising from quantum symmetric pairs of Kac-Moody type

Abstract: For quantum symmetric pairs $(U, U^\dagger)$ of Kac-Moody type, we construct $\dagger$-canonical bases for the highest weight integrable $U$-modules and their tensor products regarded as $U^\dagger$-modules, as well as an $\dagger$-canonical basis for the modified form of the $\dagger$-quantum group $U^\dagger$. Our new approach simplifies and strengthens those results for finite types as well. This is joint work with Weiqiang Wang.

Chih-Whi Chen (Xiamen University)

Title: Simple supermodules for Lie superalgebras

Abstract: The problem of classification of all simple modules for a given Lie algebra is rather difficult. Some kind of solution exists only for the Lie algebra $sl(2)$ due to Block’s classification theorem.

A Lie superalgebra is a generalization of a Lie algebra to include a $\mathbb{Z}_2$-grading $g = g_0 + g_1$. We explain the connection between simple supermodules over $g$ and simple modules over the underlying Lie algebra $g_0$. In particular, the classification of simple supermodules over Lie superalgebras can be reduced to the classification of simple modules over the underlying Lie algebra of type $A$.

This is joint work with Kevin Coulembier and Volodymyr Mazorchuk.
Zhaobing Fan (Harbin Engineering University)

**Title:** Equivariant K-theory and quantum symmetric pairs

**Abstract:** Bao-Kujawa-Li-Wang and Fan-Li provided the Schur-Weyl duality between the quantum coideal algebras and Hecke algebras of types $B/C/D$ by using equivariant functions on the isotropic flag varieties. Motivated by their works and Langlands reciprocity, we provide a geometric approach to these quantum coideal algebras of $U_q(sl_n)$ via equivariant K-theory on the steinberg varieties. This is a preliminary result joint with Haitao Ma and Husileng Xiao.

Tamas Hausel (Institute of Science and Technology Austria)

**Title:** Representations of quivers over Frobenius algebras

**Abstract:** I will discuss an arithmetic Fourier transform approach towards understanding locally-free representations of quivers over commutative Frobenius algebras. Joint work with Emmanuel Letellier and Fernando R. Villegas.

David Hernandez (Université Paris Diderot)

**Title:** Quantum Grothendieck rings, cluster mutations and Kazhdan-Lusztig polynomials

**Abstract:** Quantum Grothendieck rings are natural $t$-deformations of representations rings of quantum affine algebras. They have a structure of a quantum cluster algebra. Using distinguished equivalences of corresponding quivers, we establish ring isomorphisms between quantum Grothendieck rings in types $A$ and $B$. Combining we recent results of Kashiwara-Kim-Oh, we prove for the corresponding categories in type $B$ a conjecture formulated by the speaker in 2002: the multiplicities of simple modules in standard modules are given by the evaluation of certain analogues of Kazhdan-Lusztig polynomials and the coefficients of these polynomials are positive (joint work with Hironori Oya).

Syu Kato (Kyoto University)

**Title:** Frobenius splitting of semi-infinite flag manifolds

**Abstract:** We explain that extremal weight modules of quantum loop algebras give rise to the projective coordinate ring of the formal model of the semi-infinite flag manifolds over the ring of integers with two inverted. Then, we exhibit how this gives rise to the Frobenius splitting of such an (ind-)scheme. This particularly implies that the
Schubert varieties of the quasi-map space from a projective line to a (partial) flag manifold admits a Frobenius splitting compatible with the boundaries, and consequently such varieties are normal and has rational singularity in characteristic zero. This extends the case of the genuine quasi-map spaces by Braverman-Finkelberg and the asymptotic case by myself.

If time allows, we explain why such results are useful to understand the structure of equivariant small quantum $K$-theory of a (partial) flag manifold.

This talk is based on arXiv:1810.07106v2 and the references therein.

**Stefan Kolb** (Newcastle University)

**Title:** The quasi $K$-matrix for quantum symmetric pairs

**Abstract:** The quasi $R$-matrix for a quantized enveloping algebra plays a crucial role in the construction of braided monoidal categories and canonical bases for quantum groups. The quasi $R$-matrix is uniquely determined as an intertwiner for bar involutions, or alternatively, as a canonical element with respect to a dual pairing of the positive and negative parts of the quantized enveloping algebra. The quasi $K$-matrix is an analog of the quasi $R$-matrix in the theory of quantum symmetric pairs. The first instance of a quasi $K$-matrix was defined by H. Bao and W. Wang by an intertwiner property for bar involutions. In this talk I will give a bar-involution free description of the quasi $K$-matrix as a canonical element for a dual pairing. To this end the quantum symmetric pair coideal subalgebra is interpreted as a deformation of a partial quantum Borel subalgebra. We will restrict to symmetric pairs for which the corresponding Satake diagram has no black dots, but we will work in a general setting of doubles of Nichols algebras of diagonal type. The talk is based on joint work with Milen Yakimov.

**Jae-Hoon Kwon** (Seoul National University)

**Title:** Kirillov-Reshetikhin modules over affine superalgebras of type $A$ and their crystal bases

**Abstract:** The generalized quantum group of type $A$ is an affine analogue of quantum group associated to a general linear Lie superalgebra, introduced by Kuniba-Okaso-Sergeev in the study of solutions to the three-dimensional Yang-Baxter equation. We construct its Kirillov-Reshetikhin modules, that is, a family of its finite-dimensional irreducible modules which have crystal bases. We also have a combinatorial description of the crystal structure of Kirillov-Reshetikhin modules, the combinatorial $R$-matrix, and energy function on their tensor products. This is a joint work with Masato Okado.
Ming Lu (Sichuan University)

Title: Hall algebras and quantum symmetric pairs

Abstract: A quantum symmetric pair consists of a quantum group and its coideal subalgebra $U^i$ (called an $i$-quantum group). A quantum group is in turn an example of an $i$-quantum group associated to the symmetric pair of diagonal type. In recent years, a list of fundamental constructions for quantum groups, e.g., $R$-matrix and canonical bases, has found generalizations to $i$-quantum groups.

In this talk, we present a Hall algebra construction of $U^i$. To that end, a new class of 1-Gorenstein algebras arising from “quivers with involutions” are formulated; they fit well within the framework of modified Ringel-Hall algebras of Peng and the speaker, which are closely related to semi-derived Hall algebras of Gorsky. Our approach leads to monomial bases, PBW bases, and reflection functors for $U^i$. In case of symmetric pairs of diagonal type, our work reduces to a reformulation of Bridgeland’s Hall algebra realization of a quantum group, which in turn was a generalization of earlier constructions of Ringel and Lusztig for half a quantum group. Time permitting, we will explain a categorical/geometric counterpart of the above Hall algebra realization of $U^i$. This is joint work with Weiqiang Wang.

George Lusztig (Massachusetts Institute of Technology)

Title: A new basis of the representation ring of a Weyl group

Abstract: Let $W$ be a Weyl group. We define a family of representations of $W$ which is connected to that consisting of irreducible representations by a upper triangular matrix with 1 on the diagonal. This family contains the special representations, the left cell representations and some representations interpolating between those two types.

Volodymyr Mazorchuk (Uppsala University)

Title: 2-representations of Soergel bimodules

Abstract: In this talk I will survey recent results by various authors related to the study of 2-representations (that is functorial actions) of Soergel bimodules. The main emphasis will be on classification of “simple” 2-representations.

Dan Nakano (University of Georgia)

Title: On BBW Parabolics for Simple Classical Lie Superalgebras
Abstract: Let $\mathfrak{g}$ be a (simple) classical Lie superalgebra over the complex numbers. In this talk I will discuss the developments over the past 10 years that have led to effective methods to systematically study these algebras via the construction of detecting subalgebras. The detecting subalgebras play an important role in the theory. They completely detect the cohomology relative to the even subalgebra, and provide a structural interpretation of combinatorial invariants that were defined by Kac and Wakimoto.

Recently, the speaker with his collaborators have constructed parabolic subalgebras, $\mathfrak{b}$, (like Borel subalgebras) where the detecting subalgebras can be viewed as the Levi component. By comparing the cohomology of $\mathfrak{g}$ and $\mathfrak{b}$, we discovered an important relationship with the Poincaré series of an ambient complex reflection group via the Bott-Borel-Weil theorem. Furthermore, these Poincaré series describe the higher sheaf cohomology groups of the trivial line bundle over $G/B$ where $\mathfrak{g} = \text{Lie}G$ and $\mathfrak{b} = \text{Lie}B$.

At the end of the talk, applications will be given to verifying the conjecture due to Boe, Kujawa and Nakano on the realization of support varieties for $\mathfrak{g}$.

This talk represents joint work with D. Grantcharov, N. Grantcharov and J. Wu.

Andrei Negut (Massachusetts Institute of Technology)

Title: $q$-$W$-algebras in type $A$ as quotients of $q$-Yangians

Abstract: The purpose of the present talk is to show that the $q$-$W$-algebra of type $\mathfrak{gl}_n$ (a higher rank generalization of the deformed Virasoro algebra, which plays an important role in conformal field theory) is a quotient of a certain $q$-Yangian. The result can be interpreted as an affinized and $q$-deformed version of work by Brundan-Kleshchev, and its applications include a mathematical proof of the AGT conjecture for rank $n$ gauge theory over an algebraic surface.

Se-Jin Oh (Ewha Woman’s University)

Title: Interpretation of categorical similarities between Langlands dual quantum affine algebras via quiver Hecke algebras

Abstract: The representation theory of quantum affine algebras is intensively studied since it is closely related to many branches of mathematics and physics. Interestingly, Frenkel-Hernandez investigated that there are miraculous similarities between Langlands dual quantum affine algebras $U'_q(\mathfrak{g})$ and $U'_q(\mathfrak{l}_\mathfrak{g})$ in their seminal works. By the serial works with coworkers, I and my collaborators interpreted this similarities in terms of categorification via finite dimensional modules over quiver Hecke algebras.
(introduced by Khovanov-Lauda and Rouquier). More precisely we prove that there are small tensor subcategories $\mathcal{C}_Q$ (of Hernandez-Leclerc) and $\mathcal{C}_\mathcal{Q}$ over Langlands dual quantum affine algebras whose Grothendieck rings are isomorphic to each other as the Grothendieck ring of finite dimensional modules over quiver Hecke algebra of finite type. Main tasks of these works consist of (1) computing denominator formulas between fundamental representations and Dorey’s rules (using the notation of “minimal pairs”) (2) generalizing and analyzing Auslander-Reiten quivers $\Gamma_Q$ and $\Upsilon_{\mathcal{Q}}$ as Hasse quivers on positive roots and (3) proving that the functors (of Kang-Kashiwara-Kim) between $\mathcal{C}_Q$ and $\mathcal{C}_{\mathcal{Q}}$ are exact and send simples to simples. In particular, when $g = A_{2n-1}^t$ ($t = 1, 2$) and $\mathfrak{g} = B_n^{(1)}$, results on $\mathcal{C}_Q$ and $\mathcal{C}_{\mathcal{Q}}$ could be extended to the whole categories $\mathcal{C}_{\mathcal{Z}}$, called the Hernandez-Leclerc categories. These are joint works with Kashiwara, Kim, Park, Suh and Scrimshaw.

**Peng Shan** (Tsinghua University)

**Title:** Centre of $G_1T$-modules and affine Springer fibres

**Abstract:** Soergel proved that the centre of principal blocks of category $\mathcal{O}$ for semisimple Lie algebras is isomorphic to the cohomology ring of the corresponding flag variety. In type $A$, such an isomorphism also exists for the centre of parabolic category $\mathcal{O}$ and cohomology of Springer fibres. In this talk, we explain an analogous isomorphism for the centre of $G_1T$-modules and the cohomology of certain affine Springer fibres.

**Valerio Toledano Laredo** (Northeastern University)

**Title:** Elliptic quantum groups

**Abstract:** I will describe joint work with Sachin Gautam where we propose a definition of the category of finite-dimensional representations of an elliptic quantum group which is intrinsic, uniform for all Lie types, and valid for numerical values of the deformation and elliptic parameters. We also classify simple objects in this category in terms of elliptic Drinfeld polynomials. This classification is new even for $\mathfrak{sl}(2)$, as is our definition outside of type $A$. The talk is partly based on the preprint arXiv:1707.06469.

**Eric Vasserot** (Université Paris Diderot)

**Title:** On COHA’s of quivers and surfaces

**Abstract:** I will briefly review the theory of cohomological Hall algebras associated with a quiver, which yields geometric realizations of a new class of “quantum
algebras.” Then I will explain a generalization of COHA to sheaves on algebraic surfaces. Joint work with M. Kapranov.

Geordie Williamson (University of Sydney)

Title: A simple character formula

Abstract: I will describe a character formula for simple representations of algebraic groups involving $p$-Kazhdan-Lusztig polynomials in the spherical module. It is an analogue of Lusztig’s formula for the characters of simple and projective $G_1T$-modules in terms of periodic polynomials. This is joint work with Simon Riche.