

CONFERENCE ON LIE THEORY AND REPRESENTATION THEORY

李理论和表示论会议

Program

程序册

Tongji University, Shanghai, China

中国上海同济大学

2018.6.29-7.3

Invited Speakers:

Chengming Bai (Chern Institute, Nankai University)

Bangming Deng (Tsinghua University)

Naihong Hu (East China Normal University)

Cuipo Jiang (Shanghai Jiaotong University)

ZongZhu Lin (Kansas State University)

Yanan Lin (Xiamen University)

Hourong Qin (Nanjing University)

Brain Parshall (Virginia University)

Liangang Peng (Sichuan University)

Leonald Scott (Virginia University)

Bin Shu (East China Normal University)

Shaobin Tan (Xiamen University)

Toshiyuki Tanisaki

Weiqliang Wang (Virginia University)

Changchang Xi (Capital Normal University)

Jie Xiao (Tsinghua University)

Jiping Zhang (Peking University)

Pu Zhang (Shanghai Jiaotong University)

Scientific Committee:

Jie Du (University of New South Wales)

Shengli Tan (East China Normal University)

Nanhua Xi (Chair, Chinese Academy of Science)

Jie Xiao (Tsinghua University)

Jiping Zhang (Peking University)

Organizer Committee:

Qiang Fu (Tongji University)

Hebing Rui (Tongji University)

Yucai Su (Tongji University)

Schedule

Lecture Room: Talks will be given in 1606, Zhonghe Lou (衷和楼1606室), Shanghai, China.

Meals: Lunch and dinner are given in Tongji Guest House (同济迎宾馆) at 12:20–13:20 and 17:30–19:00. Banquet is given in Kingswell Hotel Tongji (同济君禧大酒店) at 17:30–19:00.

Schedule of the talks:

Saturday, 30 June	
9:00–9:10	Opening
9:10–10:00	B. Parshall, Jian-pan Wang and representation theory
10:00–10:10	Tea Break
10:10–11:00	Shaobin Tan, Toroidal Lie algebras and toroidal vertex algebras
11:00–11:20	Tea Break
11:20–12:10	Hourong Qin, Congruent numbers, quadratic forms and K-theory
12:10–14:00	Lunch Break
14:00–14:50	Jie Xiao, On purity theorem of Lusztig's perverse sheaves
14:50–15:00	Tea Break
15:00–15:50	Yanan Lin, Tilting objects in the stable category of vector bundles of tubular type
15:50–16:10	Tea Break
16:10–17:00	Chengming Bai, Deformations and their controlling cohomologies of \mathcal{O} -operators

Sunday, 1 July	
9:00–9:35	Nanhua Xi, Representations of Algebraic Groups
9:35–10:10	Jun Hu, Grassmannian, symmetric functions and cyclotomic nil-Hecke algebras
10:10–10:45	Qiang Fu, The quantum loop algebra of \mathfrak{gl}_n
10:45–11:05	Tea Break
11:05–11:40	Gao Yang, Spaltenstein varieties of symmetric spaces associated with orthogonal groups
11:40–12:10	Hebing Rui, Classification of finite dimensional simple modules of affine Birman-Murakami-Wenzl algebras
12:10–14:00	Lunch Break
14:00–14:35	Haixia Gu, Multiplication formulas and semisimplicity for q -Schur superalgebras
14:35–15:10	Xiaoyu Chen, Induced Representations of Reductive Groups with Frobenius Maps
15:10–15:45	Dong Liu, Whittaker Modules for the super Virasoro algebras
15:45–16:05	Tea Break
16:05–16:40	Li Wang, Setwise intersecting families in classical Coxeter Groups
16:40–17:20	Jie Du, Automata and cells in Coxeter groups—Influence of Jianyi Shi's work
17:30–19:00	Banquet

Monday, 2 July	
9:00–9:50	Jiping Zhang, On the inductive blockwise Alperin weight conditions for simple groups
10:00–10:50	Zongzhu Lin, Structures of Weyl modules and family of characters
10:50–11:10	Tea Break
11:10–12:00	Bangming Deng, Mutations in the derived category of a weighted projective line and some applications
12:00–14:00	Lunch Break
14:00–14:50	Weiqiang Wang, Stability of the centers of group algebras of $GL_n(q)$
15:00–15:50	Changchang Xi, Constructions of derived equivalences from stable equivalences
15:50–16:10	Tea Break
16:10–17:00	Pu Zhang, Frobenius subcategories and RSS equivalences

Sunday, 3 July	
9:00–9:50	Toshiyuki Tanisaki, Characters of integrable highest weight modules over a quantum group
9:50–10:00	Tea Break
10:00–10:50	Bin Shu, Super Weyl groups and some applications
10:50–11:10	Tea Break
11:10–12:00	Naihong Hu, Modular pointed finite-dimensional Hopf algebras beyond multiparameter quantum small groups
12:00–14:00	Lunch Break
14:00–14:50	Liangang Peng, On modified Ringel-Hall algebras of complexes,
14:50–15:00	Tea Break
15:00–15:50	Cuipo Jiang, Vertex operator algebras generated by Ising vectors of σ -type
15:50–16:10	Teak Break
16:10–16:40	Leonard Scott, Some tables of right set properties in affine Weyl groups of type A

Abstracts

Deformations and their controlling cohomologies of \mathcal{O} -operators

Chengming Bai

We establish a deformation theory of a kind of linear operators, namely, \mathcal{O} -operators in consistence with the general principles of deformation theories. On one hand, there is a suitable differential graded Lie algebra whose Maurer-Cartan elements characterize \mathcal{O} -operators and their deformations. On the other hand, there is an analogue of the André-Quillencohomology which controls the deformations of \mathcal{O} -operators. Infinitesimal deformations of \mathcal{O} -operators are studied and applications are given to deformations of skew-symmetric r -matrices for the classical Yang-Baxter equation. This is a joint work with Li Guo, Yunhe Sheng and Rong Tang.

Abstract Induced Representations of Reductive Groups with Frobenius Maps

Xiaoyu Chen

Let \mathbf{G} be a connected reductive group defined over the finite field \mathbb{F}_q of q elements, and \mathbf{B} be a Borel subgroup of \mathbf{G} defined over \mathbb{F}_q . It is a challenge problem to give the classification of all (abstract) irreducible \mathbf{G} . In this talk, we give the following results: We show that the abstract induced module $\mathbb{M}(\theta) = \mathbb{k}\mathbf{G} \otimes_{\mathbb{k}\mathbf{B}} \theta$ (here $\mathbb{k}\mathbf{H}$ is the group algebra of \mathbf{H} over the field \mathbb{k}) from an one dimensional representation θ of \mathbf{B} has a composition series (of finite length) if the characteristic of \mathbb{k} not equal to that of \mathbb{F}_q . In the case when $\mathbb{k} = \overline{\mathbb{F}_q}$, the algebraic closure of \mathbb{F}_q , and θ is a rational character, we give the necessary and sufficient condition for the existence of the composition series of $\mathbb{M}(\theta)$. We determine all the composition factors whenever the composition series exist. The

decomposition of such induced modules gives a large class of abstract infinite dimensional irreducible representations of \mathbf{G} . This is a joint work with Junbin Dong.

*Mutations in the derived category
of a weighted projective line and some applications*

Bangming Deng

We study the right and left mutation functors arising in the derived category of a weighted projective line in the sense of Bondal, and show that these functors give rise to some automorphisms of the associated Kac-Moody algebra, as well as of its quantized enveloping algebra. This is joint work with Shiquan Ruan and Jie Xiao.

The quantum loop algebra of \mathfrak{gl}_n

Qiang Fu

In the seminal work, Beilinson–Lusztig–MacPherson gave a beautiful realization for quantum \mathfrak{gl}_n via a geometric setting of quantum Schur algebras. This remarkable work has many applications. We will talk about BLM realization of quantum affine \mathfrak{gl}_n and its applications. This talk is mainly based on joint works with Bangming Deng and Jie Du.

Automata and cells in Coxeter groups

—*Influence of Jianyi Shi's work*

Jie Du

For a Coxeter group W and a cell of W , let $Red(C)$ be the set of reduced expressions of all elements in C . One may regard $Red(C)$ as formal language in the sense of the theory of computation. Bill Casselman (UBC) conjectured that $Red(C)$ is regular, i.e., there exists a finite state automaton accepting exactly the words in $Red(C)$. In 2010, P.

Gunnells (UMASS) proved the conjecture for affine Weyl groups. His proof is based on a generalization of Shi's arrangement and a result in my thesis! I will give an introduction to the work.

***Multiplication formulas and semisimplicity
for q -Schur superalgebras***

Haixia Gu

We investigate products of certain double cosets for the symmetric group and use the findings to derive some multiplication formulas for the q -Schur superalgebras. This gives a combinatorialisation of the relative norm approach developed in [?]. We then give several applications of the multiplication formulas, including the matrix representation of the regular representation and a semisimplicity criterion for q -Schur superalgebras. We also construct infinitesimal and little q -Schur superalgebras directly from the multiplication formulas and develop their semisimplicity criteria. This is joint work with Jie Du and Zhonguo Zhou.

***Grassmannian, symmetric functions and
cyclotomic nilHecke algebras***

Jun Hu

Let ℓ, n be positive integers such that $\ell \geq n$. There is a \mathbb{Z} -graded algebra isomorphism between the cohomology of the Grassmannian $\mathbb{G}_{n,\ell}$ and a natural \mathbb{Z} -form B of the \mathbb{Z} -graded basic algebra of the type A cyclotomic nilHecke algebra $H_{\ell,n}^{(0)}$. We show that the isomorphism can be chosen such that the image of each (geometrically defined) Schubert class (a_1, \dots, a_n) coincides with the basis element b_λ constructed in an earlier work by purely algebraic method, where $0 \leq a_1 \leq a_2 \leq \dots \leq a_n \leq \ell - n$ with $a_i \in \mathbb{Z}$ for each i , λ is the ℓ -multipartition of n associated to $(\ell + 1 - (a_n + n), \ell + 1 - (a_{n-1} + n - 1), \dots, \ell + 1 - (a_1 + 1))$. The talk is based on a joint work with Zhou Kai.

*Modular pointed finite-dimensional Hopf algebras
beyond multiparameter quantum small groups*

Naihong Hu

In this surveys talk, I will recall some of our work on the modular quantization and multiparameter quantum groups towards addressing the Drinfeld's quantization question proposed in LNM 1510, for the Lie bialgebras both for the Cartan type and the complex semisimple/affine Lie algebras, clarify the connections with the Andruskiewitsch-Schneider's classification work on the pointed finite-dimensional Hopf algebras in characteristic zero. Finally, we will propose a conjecture on modular pointed finite-dimensional Hopf algebras.

Vertex operator algebras generated by Ising vectors of σ -type

Cuipo Jiang

We prove that a simple moonshine type vertex operator algebra generated by Ising vectors of σ -type is uniquely determined by its Griess algebra. With this result, we give characterization of all the simple moonshine type vertex operator algebras generated by Ising vectors of σ -type. In particular, we prove that the moonshine type vertex operator algebra generated by Ising vectors of σ type with the associated 3-transposition group being S_n is simple and isomorphic to the rational vertex operator algebra $C_{L_2^{\otimes n}}(L_{\widehat{sl_2}}(n, 0))$. We conjecture that any simple moonshine type vertex operator algebras generated by Ising vectors is uniquely determined by its Griess algebra and further the moonshine type vertex operator algebras generated by Ising vectors of σ -type are simple and rational. This is based on joint work with Ching Hung Lam and Hiroshi Yamauchi.

*Tilting objects in the stable category of vector
bundles of tubular type*

Yanan Lin

We will focus on the study of the stable category of vector bundles for the weighted projective lines of weight tripe. We find some important triangles in this category and use them to construct tilting objects with tubular endomorphism algebras for the case of genus one via cluster tilting theory. We realized the construction of a tubular tilting object for each weighted projective line of genus one. This is joint work with Jianmin Chen and ShiquanRuan.

Structures of Weyl modules and family of characters

Zongzhu Lin

Lusztig constructed a collection of characters using Kazhdan-Lusztig polynomials recursively and showed that they are characters of irreducible modules for a semisimple algebraic group. I will construct an infinite family of characters also using Kazhdan-Lusztig polynomials and prove that they are characters of actual modules. For each family, every Weyl module has filtration with subquotients having characters lie in this family.

Whittaker Modules for the super Virasoro algebras

Dong Liu

In this talk we introduce some results of Whittaker modules over the super Virasoro algebras. We first classify all finite-dimensional irreducible modules over the positive part of the super Virasoro algebras. Induced from those simple modules, Whittaker modules over the super Virasoro algebras are defined, and the criterions of simplicity for these Whittaker modules are also obtained.

Jian-pan Wang and representation theory

Brian Parshall

The work of Jian-pan Wang has tremendously influenced the development of the representation theory of algebraic and quantum groups, among other topics. He has also played a major role in making China a top world leader in these fields today. In my presentation, I will discuss several of Wang's results in modular representations of semisimple groups and in q -Schur algebras and indicate how they have continued to evolve in mathematics today.

On modified Ringel-Hall algebras of complexes

Liangang Peng

In this talk I shall introduce my work jointed with LU Ming or LIN Ji on the modified Ringel-Hall algebra of period or bounded complexes of a hereditary abelian category. This is a kind of Ringel-Hall algebras which has a nice structure and is related directly to the Drinfeld double, Green's formula on Ringel-Hall numbers, the derived Hall algebras and etc.

Congruent numbers, quadratic forms and K-theory

Hourong Qin

A positive integer is called a congruent number if it is the area of a right-angled triangle, all of whose sides have rational length. A celebrated theorem due to Tunnell gives a criterion for a positive integer to be congruent (under the BSD). In this talk, we present a new criterion. We show that if a square-free and odd (respectively, even) positive integer n is a congruent number, then

$$\#\{(x, y, z) \in \mathbb{Z}^3 | n = x^2 + 2y^2 + 32z^2\} = \#\{(x, y, z) \in \mathbb{Z}^3 | n = 2x^2 + 4y^2 + 9z^2 - 4yz\},$$

respectively,

$$\#\{(x, y, z) \in \mathbb{Z}^3 | \frac{n}{2} = x^2 + 4y^2 + 32z^2\} = \#\{(x, y, z) \in \mathbb{Z}^3 | \frac{n}{2} = 4x^2 + 4y^2 + 9z^2 - 4yz\}.$$

If we assume that the weak Brich-Swinnerton-Dyer conjecture is true for the elliptic curves $E_n : y^2 = x^3 - n^2x$, then, conversely, these equalities imply that n is a congruent number.

We shall also discuss some applications. In particular, we show that if $p \equiv 1 \pmod{8}$ is a prime, then p is a congruent number implies that the 8-rank of $K_2O_F = 1$, where $F = \mathbb{Q}(\sqrt{p})$ and O_F the ring of integers in F .

***Classification of finite dimensional simple modules
of affine Birman-Murakami-Wenzl algebras***

Hebing Rui

I will explain my results on the classification of finite dimensional simple modules of affine Birman-Murakami-Wenzl algebras over complex field.

***Some tables of right set properties in affine
Weyl groups of type A***

Leonard Scott

This title of this talk coincides with the title of a recent arXiv posting, 1806.02797 in math.RT, a joint paper of the speaker with a student, Ethan Zell. The tables of the title are a first attempt to understand empirically the sizes of certain distinguished sets, introduced by Han-kyungKo, of elements in affine Weyl groups. The sizes are relevant to the computational efficiency of direct approaches to computing characters of irreducible modular representations of algebraic groups, starting from characters of irreducible representations of quantum groups.

Super Weyl groups and some applications

Bin Shu

In this talk, I will introduce super Weyl groups for basic classical Lie super algebras, and their some applications, including: Jantzen filtration and sum formula, strong linkage principle, and some special BGG theorem.

Toroidal Lie algebras and toroidal vertex algebras

Shaobin Tan

In this talk, we deal with the theory of toroidal vertex algebras and their (twisted) modules. We establish natural associations of toroidal vertex algebras and (twisted) modules to (twisted) toroidal Lie algebras. We also construct a toroidal vertex algebra and show that the category of restricted modules for the toroidal Lie algebra is canonically isomorphic to that of modules for the toroidal vertex algebra. The talk is based on joint work with Professor H. Li and Professor Q. Wang.

Characters of integrable highest weight modules over a quantum group

Toshiyuki Tanisaki

We show that the Weyl-Kac type character formula holds for the integrable highest weight modules over the quantized enveloping algebra of any symmetrizable Kac-Moody Lie algebra, when the parameter q is not a root of unity.

Setwise intersecting families in classical Coxeter Groups

Li Wang

Let Ω be a finite set and G a permutation group acting on it. A subset H of G is called *t-set-intersecting* if for any two elements $\sigma, \pi \in H$, there exists a t -set $T \subset \Omega$ such that $\sigma(T) = \pi(T)$. Let S_n^D and S_n^B be the classical Coxeter group of type D_n and type B_n respectively. We show that the maximum-sized t -set-intersecting families in S_n^D and S_n^B are precisely cosets of stabilizers of t -set of $[n]$ provided n is sufficiently large depending on t .

Stability of the centers of group algebras of $GL_n(q)$

Weiqliang Wang

The center of the integral group algebra of the general linear group $GL_n(q)$ over a finite field admits a filtration with respect to the reflection length. We show that the structure constants of the associated graded algebras $G_n(q)$ are independent of n , and this stability leads to a universal stable center with positive integer structure constants which governs the algebras $G_n(q)$ for all n . Various structure constants of the stable center are computed, leading to conjectural generic structure constants. Analogous stability properties for symmetric groups and wreath products were known earlier. This is joint work with Jinkui Wan.

Constructions of derived equivalences from stable equivalences

Changchang Xi

Derived categories and equivalences are widely applied in representation theory. In this talk, we shall provide methods to construct derived **equivalences from stable equivalences** for algebras. This construction can be employed to verify an important conjecture, the Broue's Abelian Defect Group Conjecture, for some block algebras in the modular representation theory of finite groups.

Representations of Algebraic Groups

Nanhua Xi

On purity theorem of Lusztig's perverse sheaves

Jie Xiao

In this talk, we prove that the simple perverse sheaves which provide the canonical basis of a quantum group has the strong purity property. As an application, the existence of a class of Hall polynomials will be proved. A joint work with F.Xu and M.Zhao.

*Spaltenstein varieties of symmetric spaces
associated with orthogonal groups*

Gao Yang

The Spaltenstein variety was first studied by Spaltenstein, in the special case of general linear group. Then Borho and MacPherson considered the Spaltenstein variety in general. Back to the general linear group case, Lusztig related the cohomology of Spaltenstein varieties to the Green functions. After that, Achar and Henderson considered the Spaltenstein varieties for enhanced spaces, and proved certain properties of these varieties, including their connection with modified Kostka polynomials.

In this talk, we will define the Spaltenstein varieties for symmetric spaces associated with orthogonal groups. Here, some of the structural properties of these varieties will be given, and the definition of Green functions will be considered.

*On the inductive blockwise Alperin weight conditions
for simple groups*

Jiping Zhang

The blockwise Alperin weight conjecture claims that for any finite group G and any prime p , the number of the Brauer characters in a p -block B equals the number of the G -conjugacy classes of p -weights in B . Recently, the inductive blockwise Alperin weight conditions have been introduced such that the blockwise Alperin weight conjecture holds if all non-abelian simple groups satisfy these conditions. We will report important progress in verifying these inductive conditions for finite simple groups.

Frobenius subcategories and RSS equivalences

Pu Zhang

We introduce and show the existence of the Ringel-Schmidmeier-Simson equivalence, between the separated monomorphism category $\text{smon}(Q, I, \mathcal{X})$ and its dual $\text{sepi}(Q, I, \mathcal{X})$, where Q is an acyclic quiver, I an admissible ideal of kQ generated by monomial relations, A a finite-dimensional algebra, and \mathcal{X} is an additive full subcategory of $A\text{-mod}$. This separated monomorphism category $\text{smon}(Q, I, \mathcal{X})$ is introduced combinatorially, but it admits a homological interpretation, and enjoys a reciprocity $\text{smon}(Q, I, {}^\perp T) = {}^\perp(T \otimes kQ/I)$ for a cotilting A -module T . It describes Gorenstein-projective Λ -modules as $\mathcal{GP}(\Lambda) = \text{smon}(Q, I, \mathcal{GP}(A))$, where $\Lambda := A \otimes_k kQ/I$. As an application of such an RSS equivalence, $\text{smon}(Q, I, \mathcal{X})$ is an extension-closed Frobenius subcategory if and only if so is \mathcal{X} . This gives a construction of “new” Frobenius subcategories in the sense that they may be not $\mathcal{GP}(\Lambda)$.