Conference on “Infinite Dimensional Lie Theory and its Applications”

(15-20 December, 2014)

Title & Abstract

S. No.	Name	Title	Abstract
1	Yuly Billig	Proof of Rao's conjecture on classification of simple modules for the Lie algebra of vector fields.	We establish the classification of all simple modules with finite-dimensional weight spaces over Lie algebra of vector fields on n-dimensional torus for any n. As conjectured by Eswara Rao, every such module is either of a highest weight type or is a quotient of a module of tensor fields on a torus. Our result generalizes the classical theorem of O.Mathieu (Kac's conjecture) on simple weight modules for the Virasoro algebra (n = 1). This is a joint work with Slava Futorny.
		Eswara Rao's contribution to representation theory.	We will discuss the works of Professor Eswara Rao and their impact on the infinite-dimensional representation theory.
2	Vyacheslav Futorny	Quantization of the shift of argument subalgebras in type A	If g is a simple Lie algebra then every μ ∈ g* defines a shift of argument subalgebra of S(g) which is Poisson commutative (originaly defined by Mischenko and Fomenko and studied by Rybnikov). When μ is a regular element then this subalgebra is known to admit a quantization, i.e. it can be lifted to a commutative subalgebra of the universal enveloping algebra U(g) (problem studied by Vinberg). We show that if g is of type A then this property holds for arbitrary μ, which was previously conjectured by Feigin, Frenkel and Toledano Laredo. This a joint work with Alexander Molev from the University of Sydney (Australia).
3	Kailash C. Misra	On Tensor Product Decomposition of $\widehat{\mathfrak{sl}}(n)$ Modules and Identities	We decompose the $\widehat{\mathfrak{sl}}(n)$-module $V(\Lambda_0) \otimes V(\Lambda_i)$ using extended Young diagram realization of the associated crystal base and give generating function identities for the outer multiplicities. In the process we discover some seemingly new partition identities for $n=3, 4$.

4	Shaobin Tan	Module categories for toroidal Lie algebras.	TBA
5	Hiroyuki Yamane	Representation theory of generalized quantum groups	TBA
6	Saeid Azam	Finite dimensional unitary Lie superalgebras	We describe unitary Lie superalgebras, namely Lie superalgebras which have a faithful finite dimensional unitary representation. To achieve this, we need to analyze the decomposition of reductive Lie superalgebras (g is a semisimple g¯0 - module) over fields of characteristic zero into ideals.This talk is based on a joint work with Karl-Hermann Neeb.
7	Malihe Yousofzadeh	Root Graded Lie Superalgebras	We define root graded Lie superalgebras and study their connection with centerless cores of extended affine Lie superalgebras; our definition generalizes the known notions of root graded Lie superalgebras.
8	Michael Lau	Representations of current algebras and their twisted analogues	Evaluation modules were introduced by Chari and Rao about 25 years ago to classify the finite-dimensional simple modules of affine Lie algebras (derived algebras modulo their centres). A number of recent papers have used evaluation modules to describe the finite-dimensional representation theory of multiloop and other generalisations of these algebras. We explain how these techniques can be combined with ideas from descent theory to give a unified treatment of all such representations. We close with some new results on (potentially infinite-dimensional) weight modules for generalised current algebras, obtained in joint work with Britten and Lemire.
9	Drazen Adamovic	Vertex algebras and Whittaker modules for affine Lie algebras	In this talk we shall study Whittaker modules for affine Lie algebras as modules for universal affine vertex algebras. We shall discuss a role of Whittaker categories in the representation theory of affine vertex algebras. We will present a complete description of Whittaker modules for the affine Lie algebra A_1 ^(1) at arbitrary level. A particular emphasis will be put on explicit bosonic realization of Whittaker modules at the critical level. This is a joint work with R. Lu and K. Zhao
10	Sergey Loktev	Weyl modules over multi-variable currents	Weyl modules are defined as universal finite-dimensional highest weight representations of current algebras. In general they

			are reducible but indecomposable. They generalize Demazure modules of simply-laced affine Lie algebras, and in particular cases they are Schur-Weyl dual to the space of diagonal harmonics.
11	Sachin Sharma	Integrable modules for Lie torus.	Centerless Lie tori play an important role in explicitly constructing the extended affine Lie algebras; they play similar role as derived algebras modulo center play in the realization of affine Kac-Moody algebras. In this talk we consider the universal central extension of a centerless Lie torus and classify its irreducible integrable modules when the center acts non-trivially. They turn out to be highest weight modules for the direct sum of finitely many affine Lie algebras upto an automorphism.
12	R. Venkatesh	Chromatic polynomials of graphs from kac-moody algebras.	We give a new interpretation of the chromatic polynomial of a simple graph G in terms of the Kac-Moody Lie algebra g with Dynkin diagram G. We show that the chromatic polynomial is essentially the q-Kostant partition function of g evaluated on the sum of the simple roots. Applying the Peterson recurrence formula for root multiplicities of g, we obtain a new realization of the chromatic polynomial as a weighted sum of paths in the bond lattice of G.
13	Jie Sun	Central extensions of infinite dimensional Lie algebras	Central extensions play important roles in infinite dimensional Lie theory. Many central extensions have applications in physics since central extensions reduce the study of projective representations to the study of true representations. In this talk, various techniques will be discussed to construct central extensions of infinite dimensional Lie algebras including twisted forms, extended affine Lie algebras, locally finite Lie algebras, root graded Lie algebras, direct limit Lie algebras. Many of these techniques work for Lie superalgebras as well. The universality of these constructions will also be studied.
14	Gordan Radobolja	Application of VOA to representation theory of $W\left(2,2\right)$-algebra and the twisted Heisenberg-Virasoro	In this talk we discuss weight representations of two Virasoro-like algebras: the W-algebra $W(2,2)$ and the twisted Heisenberg-Virasoro algebra at level zero $\mathcal{H}$. We present the structure of Verma modules and

		algebra	formulas for singular and cosingular vectors in these algebras. These formulas are crucial for proving irreducibility of tensor products of irreducible module from intermediate series and irreducible highest weight module. Throughout the talk we see an interesting interplay with theory of VOA. Using vertex-algebraic methods we construct singular vectors in certain Verma modules over $\mathcal{H}$. On the other hand, tensor product modules are closely related to fusion rules for irreducible $\mathcal{H}$-modules. Finally, we give a nontrivial homomorphism between vertex-algebras $W(2,2)$ and $\mathcal{H}$. As a consequence, highest weight $\mathcal{H}$-modules are also $W(2,2)$-modules. Part of the talk is based on a recent joint work with Dra\v{z}en Adamovi\'{c}.
15	Tanusree Khandai	A categorical approach towards Weyl Modules	Global and local Weyl Modules were introduced by Chari and Pressley in the context of affine Lie algebras. Later, Feigin and Loktev considered a more general case by replacing the polynomial ring with the coordinate ring of an algebraic variety. We show that there is a natural definition of the local and global modules via homological properties. This characterization allows us to define the Weyl functor from the category of left modules of a commutative algebra to the category of modules for a simple Lie algebra. As an application we are able to understand the relationships of these functors to tensor products, generalizing previous results.
16	Hiroshi Yamauchi	Sporadic finite simple groups and Conway-Miyamoto correspondence	A mysterious connection is known to exist between finite simple groups and vertex operator algebras. The study of centralizers of involutions played a central role in the classification of finite simple groups. In this talk I will explain Miyamoto's construction of involutions of a vertex operator algebra based fusion algebras. Then I will exhibit several examples of sporadic finite simple groups acting on vertex operator algebras and corresponding results of the

			Conway-Miyamoto type.
17	Yanan Lin	From Tubular Algebras to Elliptic Lie Algebras	This is joint work with Liangang-Peng. We study relations between tubular algebras of Ringel and elliptic Lie algebras in the sense of Saito-Yoshii. Using the explicit structure of the derived categories of tubular algebras given by Happel Ringel, we prove that the elliptic Lie algebra of type $D_4^{(1,1)}$, $E_6^{(1,1)}$, $E_7^{(1,1)}$ or $E_8^{(1,1)}$ is isomorphic to the Ringel-Hall Lie algebra of the root category of the tubular algebra with the same type. As a by-product of our proof, we obtain a Chevalley basis of the elliptic Lie algebra following indecomposable objects of the root category of the corresponding tubular algebra. This can be viewed as an analogue of the Frenkel-Malkin-Vybornov theorem in which they described a Chevalley basis for each untwisted affine Kac-Moody Lie algebra by using indecomposable representations of the corresponding affine quiver.
18	Apoorva Khare	Faces and supports of highest weight modules	I will report on recent progress in the study of arbitrary highest weight modules $\mathbb{V}^\lambda$, for all highest weights λ and over any complex semisimple Lie algebra $\mathfrak{g}$. The results in our talk are threefold. First, we present three formulas to compute the set of weights of all simple highest weight modules (and others) over $\mathfrak{g}$. These formulas are direct and do not involve cancellations. Our results extend the notion of the Weyl polytope to general highest weight $\mathfrak{g}$-modules (and the Weyl Character Formula to most simple modules). Second, we classify and describe the vertices, faces, and their symmetries for a very large class of highest weight modules, including all parabolic Verma modules and their simple quotients. Third, we completely classify inclusion relations between standard parabolic faces of arbitrary modules $\mathbb{V}^\lambda$, in the process extending results of Vinberg, Chari, Cellini, and others from finite-dimensional modules to all highest weight modules.