Vertex algebras and related topics

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ABSTRACTS

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Combinatorial bases of principal subspaces of standard modules for twisted affine Lie algebras of type $A^{(2)}_{2l-1}$, $D^{(2)}_l$, $E^{(2)}_6$ and $D^{(3)}_4$

Marijana Butorac, University of Rijeka

We consider principal subspaces of standard modules of level $k \geq 1$ with highest weight $k\Lambda_0$ for the twisted affine Lie algebras of type $A^{(2)}_{2l-1}$, $D^{(2)}_l$, $E^{(2)}_6$ and $D^{(3)}_4$. By using the theory of vertex operator algebras, we find combinatorial bases of principal subspaces. From combinatorial bases, we obtain the characters of principal subspaces. This talk is based on joint work with Christopher Sadowski.

Partition identities and affine Lie algebras

Stefano Caparelli, University of Rome

I will review some old developments in the study of partition identities related to the representation theory of affine Lie algebras and sketch some rough ideas about possible new approaches.

Unramified representations of the metaplectic group

Igor Ciganović, University of Zagreb

We present Zelevinsky classification of irreducible unramified representations of the p-adic metaplectic group in three steps. First, every unramified representation is a fully parabolically induced representation from unramified characters of general linear groups and a negative unramified representation of a smaller metaplectic group. Then, negative unramified representations are described in terms of parabolic induction from unramified characters of general linear groups and strongly negative unramified representation of a smaller metaplectic group, while strongly negative unramified representations are classified in terms of Jordan blocks.

Combinatorial approach to partition identities from representation theory

Jehanne Dousse, University of Zürich

A partition of a positive integer n is a non-increasing sequence of positive integers whose sum is n. A Rogers-Ramanujan type identity is a theorem stating that for all n,

the number of partitions of n satisfying some difference conditions equals the number of partitions of n satisfying some congruence conditions. Lepowsky and Wilson were the first to exhibit a connection between Rogers-Ramanujan type partition identities and representation theory in the 1980's, followed by Capparelli, Meurman, Primc, and others. This gave rise to many interesting new identities unknown to combinatorialists. In this talk I will present a new combinatorial approach, based on Alladi and Gordon's method of weighted words, which allows one to refine and generalise partition identities. I will illustrate it on Capparelli's identity and one of Primc's identities from crystal base theory.

Level-rank duality for some affine vertex operator algebras

Cuipo Jiang, Shanghai JiaoTong University

We will talk about relations between coset vertex operator algebras and tensor decompositions of some affine vertex operator algebras, which may be viewed as a version of level-rank duality. This talk is based on joint works with Zongzhu Lin and Ching-Hung Lam.

The intermediate vertex subalgebras of the lattice vertex operator algebras

Kazuya Kawasetsu, University of Melbourne

In this talk, we introduce a notion of intermediate vertex subalgebras of lattice vertex operator algebras, as a generalization of the notion of principal subspaces. We give bases and the graded dimensions of such subalgebras. As an application, we show that the characters of some modules of an intermediate vertex subalgebra between E_7 and E_8 lattice vertex operator algebras satisfy some modular differential equations. This result is an analogue of the result concerning the "hole" of the Deligne dimension formulas and the intermediate Lie algebra between the simple Lie algebras E_7 and E_8.

Etingof–Kazhdan's quantum universal affine vertex algebra

Slaven Kožić, University of Zagreb

We will present some recent results concerning the Etingof–Kazhdan's quantum universal affine vertex algebra in type A and their applications. The talk is based on joint

works with N. Jing, A. Molev and F. Yang.

Orbifold VOAs associated with coinvariant sublattices of Leech lattices

Ching Hung Lam, Institute of Mathematics, Academia Sinica

Let L be an even unimodular lattice and $g \in O(L)$. Let L^g be the fixed point sublattice and $L_g = \{a \in L | (a, b) = 0 \text{ for all } b \in L^g\}$, the coinvariant sublattice.

We show that the orbifold VOA $V_{L_g}^{\hat{g}}$ has group like fusion, where $\hat{g}$ is a lift of g in $Aut(V_{L_g})$. We also determine the fusion group and the structure of the corresponding quadratic space.

By applying the result to the Leech lattice, we verified a conjecture of G. Höhn about certain orbifold VOA associated with coinvariant lattices of the Leech lattice.

Points of view on combinatorial bases

James Lepowsky, Rutgers University

My very fortunate (for me) collaboration with Mirko Primc began in the very early 1980s. We continued in the spirit of the "Z-algebra" program that Robert Wilson and I had started by constructing "combinatorial bases" for the higher-level standard modules for the affine Lie algebra $\hat{sl}(2)$ using certain new untwisted vertex-operator-theoretic structures. This was before vertex operator algebra theory came into being, and work such as this in fact played an important role in the development of that extensive theory. But as is well known, it has proved to be very difficult to generalize the $\hat{sl}(2)$ theorem in a uniform way, despite the huge amount of important work that many people have done, including many people at this conference. I'll (selectively) sketch a few of the many significant research programs that have been and are being successfully developed, and I'll discuss some reasons why new ideas are needed.

Bases of the integrable highest weight modules of $\mathfrak{sl}(2, \mathbb{C})^\sim$

Arne Meurman, Lund University

We recall the joint work with Mirko Primc that led to a Poincare-Birkhoff-Witt type basis in each integrable highest weight module of the affine Lie algebra $\mathfrak{sl}(2, \mathbb{C})^\sim$.

Kazhdan-Lusztig algorithm for Whittaker modules

Dragan Miličić, University of Utah

The category of Whittaker modules was introduced by Kostant in his seminal paper "On Whittaker vectors and representation theory" in Inventiones in 1978. In this paper, Kostant proved that, in nondegenerate case, the category of Whittaker modules with a given infinitesimal character is semisimple with a unique irreducible object.

McDowell considered the general case and introduced the notion of standard Whittaker module (which generalizes the notion of Verma module) and proved that they are of finite length. Soergel and Milicic localized the category of Whittaker modules and showed that D-module theory makes these results almost obvious. Unfortunately, at that time the proof of analogue of Kazhdan-Lusztig conectures for Whittaker modules was out of reach, since the localizations of Whittaker modules have irregular singularities and the decomposition theorem was known only for D-modules of geometric origin. In another paper, Soergel and Milicic solved the multiplicity problem for standard Whittaker modules by establishing an equivalence of categories with a category of highest weight modules (for singular infinitesimal character).

Recently, Mochizuki established the decomposition theorem for arbitrary holonomic D-modules. Using this result, Anna Romanov in her Ph.D. thesis managed to prove the analogues of Kazhdan-Lusztig conjectures for Whittaker modules, completing the above program. Her result gives formulas for Whittaker Kazhdan-Lusztig polynomials in terms of "classical" Kazhdan-Lusztig polinomials.

Griess subalgebra and multivariable modular forms

Masahiko Miyamoto, University of Tsukuba

In our paper with Krauel, we have treated each lattice theta function as a quatient of trace functions of Griess subalgebra, isomorphic to Siegel space, on a VOA and its subVOA, and then we have proved the modular invariance property of Siegel type. In this talk, I will show you another example of such multivariable modular form given by a VOA and its subVOA.

Collapsing levels and the representation theory of affine vertex algebras

Paolo Papi, University of Rome

The talks deals with subjects covered in several joint papers with Adamovic, Kac, Moseneder, Perse. In studying the embeddings of affine algebras in minimal W-algebras we introduced the notion of collapsing level. I'll discuss our recent discover of a large class

of simple affine vertex algebras $V_k(\mathfrak{g})$, associated to basic Lie superalgebras $\mathfrak{g}$ at non–admissible collapsing levels k, having exactly one irreducible $\mathfrak{g}$–locally finite module in the category $\mathcal{O}$. In the case when $\mathfrak{g}$ is a Lie algebra, we prove a complete reducibility result for $V_k(\mathfrak{g})$–modules at an arbitrary collapsing level.

Some combinatorial coincidences for standard representations of affine Lie algebras

Mirko Primc, University of Zagreb

In some cases the combinatorial parametrizations of bases of standard modules for affine Lie algebras coincide with the combinatorial parametrizations of bases of Feigin-Stoyanovsky-type subspaces of (some other) standard modules. A particular case is the correspondence of the combinatorial bases of $A_1^{(1)}$–vacuum modules and the combinatorial bases of Feigin-Stoyanovsky-type subspaces of $B_2^{(1)}$–vacuum modules.

Free field realization of twisted Heisenberg-Virasoro algebra at level zero and $W(2,2)$ algebra

Gordan Radobolja, University of Split

We present a free field representation of twisted Heisenberg-Virasoro algebra at level zero $\mathcal{H}$. We consider a screening operator Q acting on a rank two Heisenberg algebra and associated Fock space such that $\ker Q$ extends Heisenberg-Virasoro vertex algebra. In this way we obtain a large family of highest weight representations, explicit formulas for singular vectors in Verma modules, and fusion rules for an interesting subcategory of these modules. In order to realize the missing representations we consider a deformed action of $\mathcal{H}$ on a Fock space and on Whittaker modules. In this process we construct logarithmic modules with different types of highest weight modules as subquotients. In particular we show that there exists a non-split self-extension of irreducible self-dual module which is a logarithmic module of rank two. Furthermore, we consider a $W(2,2)$ algebra which can (as a vertex algebra) be embedded in $\mathcal{H}$. We provide branching rules and a screening operator whose kernel is a $W(2,2)$ VOA.

This is a joint work with Dražen Adamović.

q-Virasoro algebra and affine Kac-Moody algebra

Shaobin Tan, Xiamen University

For an abelian group S, we introduce an infinite-dimensional Lie algebra D_S. Indeed, If S is an additive group of integers, D_S reduces to the q-Virasoro algebra D_q introduced by Belov and Chaltikian in the studying of lattice conformal theories. By applying the theory of vertex algebras, we prove that D_S is isomorphic to the S-covariant algebra of a certain affine Lie algebra, and establish the relationship between the q-Virasoro algebra D_q and affine Kac-Moody Lie algebras. More specifically, we show that if S is a finite abelian group of order $2n+1$, D_S is isomorphic to the affine Kac-Moody algebra of type B.

Bases of Feigin-Stoyanovsky's type subspaces

Goran Trupčević, University of Zagreb

We review and discuss some results about combinatorial bases of Feigin-Stoyanovsky's type subspaces for Lie algebras of type A-D. This talk is based on joint works with Baranović and Primc.

Representations of $\mathbb{Z}_2$-Orbifold of Parafermion Vertex Operator Algebras

Qing Wang, Xiamen University

The irreducible modules for the $\mathbb{Z}_2$-orbifold vertex operator subalgebra of the Parafermion vertex operator algebra associated to the integrable highest weight modules for the affine Kac-Moody algebra $A_1^{(1)}$ of level k are classified and constructed. This is a joint work with Cuipo Jiang.

Admissible level $\mathfrak{osp}(1|2)$ minimal models and their relaxed highest weight modules

Simon Wood, Cardiff University

In this talk I will present a recent classification of simple positive energy modules over the simple quotients of the $\mathfrak{osp}(1|2)$ affine vertex operator superalgebras at admissible levels.