

Schedule

Mon, Dec 8	Tue, Dec 9	Wed, Dec 10	Thu, Dec 11	Fri, Dec 12
7:30-8:30 breakfast	7:30-8:30 breakfast	7:30-8:30 breakfast	7:30-8:30 breakfast	7:30-8:30 breakfast
9:30-10:30 Kawasetsu	10:45-11:45 Möller	8:45-9:45 Dousse	9:30-10:30 Habiro	9:30-10:30 Dai
10:45-11:45 Genra	12:00-13:00 lunch	10:00-11:00 Ito	10:45-11:45 Hikami	10:45-11:45 Arakawa
12:00-13:00 lunch	13:15-14:15 Lam	11:15-12:15 Warnaar	12:00-13:00 lunch	
13:30-14:30 Kontrec	maccha (by reservation)	12:30-13:30 lunch	13:30-14:30 Murakami	
14:45-15:45 Nakatsuka	15:15-16:15 Moriwaki	free discussion	14:45-15:45 Sugimoto	
16:15-17:15 Li	16:30-17:30 Shimizu	18:00-19:00 dinner	16:15-17:15 Matsusaka	
18:00-19:00 dinner	18:00-19:00 dinner		18:00-20:00 banquet	

Title and abstract (Dec 8)

1. Kazuya Kawasetsu (Kumamoto University): On lisse non-admissible minimal and principal W -algebras

In this talk, we discuss a possible generalization of a result on the rationality of non-admissible minimal W -algebras. We then apply this generalization to finding rational non-admissible principal W -algebras. This is a joint work with T. Arakawa and T. Creutzig.

2. Naoki Genra (Toyama University): Poisson geometry and BRST reductions of vertex algebras

Let X be a Poisson variety with a Hamiltonian action of N whose Lie algebra \mathfrak{n} is nilpotent, S be a closed subvariety isomorphic to the Hamiltonian reduction of X by N , and V be a vertex algebra with an action of the loop algebra \mathfrak{n} such that the graded algebra is the arc space of X . Under the suitable conditions, using ideas of Arakawa-Moreau, we prove that the BRST cohomology of V vanishes except for the 0th, and that the graded algebra of the 0th is isomorphic to the arc space of S . Applying to affine vertex algebras and W -algebras, we obtain that the algebraic structures of W -algebras are independent of the choice of good gradings, only depending on nilpotent orbits, and that the BRST reductions of W -algebras are isomorphic to other W -algebras under step conditions, which we call reduction by stages. These proofs invoke ideas of Arakawa-Kuwabara-Malikov. We may also discuss BRST reductions of V -modules and their applications to the representation theory of W -algebras, if time permits. This is joint work with Thibault Juillard.

3. Ana Kontrec (RIMS): Kazama-Suzuki duality between certain simple W -algebras

One of the most important families of vertex algebras are affine vertex algebras and their associated W -algebras, which are connected to various aspects of geometry and physics. The notion of Kazama-Suzuki dual was first introduced in the context of the duality of the $N = 2$ superconformal algebra and affine Lie algebra $\widehat{\mathfrak{sl}}(2)$. I will present some old and new Kazama-Suzuki dualities between affine W -algebras and vertex superalgebras. This is joint work with D. Adamovic.

4. Shigenori Nakatsuka (FAU Erlangen): On the center of affine Lie superalgebras at the critical level

The completed enveloping algebras of affine Lie algebras are known to have a big center at the critical level. Indeed, it gives the function space of certain differential operators over the punctured disk with values in its Langlands dual Lie algebra. This was conjectured originally by Drinfeld and proved by Feigin and Frenkel around 1990, which was one of the motivations to introduce the principal affine W -algebras and their duality. The generalization to the super setting has been a challenge since then. However, the recent developments of the duality of W -superalgebras provide a satisfactory picture to understand them, including its relation to the pseudo-differential operators and 3d partitions. I will report the type A case based on an ongoing project with D. Adamovic and B. Feigin.

5. Hao Li (RIMS): Representation Categories of Principal W -Algebras

Principal W -algebras are central vertex operator algebras with close connections to tensor categories of quantum groups. After a brief review of Arakawa's results on the minimal-series case, I will outline how the tensor structure evolves in the non-rational regime. The talk surveys current directions for the representation categories of principal W -algebras beyond rationality and reports ongoing works (including joint work in progress).

Title and abstract (Dec 9)

1. Sven Möller (Universität Hamburg): New character identities between modules of affine and Virasoro vertex operator algebras

There is a simple relation between the characters of the universal affine vertex operator algebra for sl_2 and the universal Virasoro vertex operator algebra. Remarkably, this relation descends also to the simple quotients, relating the admissible level $k = -2 + q/p$ to the $(q, 3p)$ minimal models. The correspondence also relates various kinds of modules of these vertex operator algebras (including relaxed highest-weight modules).

In the integral case, i.e. for $p = 1$, this yields a monoidal equivalence of the corresponding representation categories, which turn out to be Galois conjugates.

The correspondence even extends to the logarithmic case, $q = 1$, where it can be related to Schur indices of certain $4d$ $N=2$ superconformal field theories, as was previously studied in the physics literature.

This is joint work in progress with Dražen Adamović.

2. Ching Hung Lam (Academia Sinica): Extra automorphisms of cyclic orbifolds of lattice VOA

TBA

3. Yuto Moriwaki (RIKEN, iTHEMS): On mathematical formulation of conformal field theory

Quantum field theory possesses various formulations, including the Wightman axioms using distributions, the Glimm-Jaffe axioms using probability measures, and factorization algebras using homology algebra. This talk discusses the formulation using vertex operator algebras in quantum field theory with conformal symmetry (conformal field theory) and its relationship with other formulations. The significance of the vertex operator algebra approach lies in its ability to explicitly construct quantum field theory using representation theory. This provides a framework for formulating and verifying various conjectures in physics, such as mirror symmetry, obtained through research in quantum field theory and string theory.

4. Kenichi Shimizu (Shibaura Institute of Technology): An algebraic theory for simple current extensions

Some constructions for vertex operator algebras (VOAs) have been understood in terms of commutative algebras in braided monoidal categories. In particular, an extension A of a VOA V with $\text{Rep}(V)$ nice enough can be viewed as a commutative algebra in (a suitable completion of) the braided monoidal category $\text{Rep}(V)$. The category $\text{Rep}(A)$ is then equivalent to the category of so-called local A -modules in $\text{Rep}(V)$. In this framework, a simple current extension of V corresponds to a commutative algebra in $\text{Rep}(V)$ whose underlying object is a direct sum of mutually non-isomorphic invertible objects. This leads us to formulate and study "algebras of simple current extension type" in a braided tensor or a braided Grothendieck-Verdier category not necessarily of the form $\text{Rep}(V)$. In this talk, I will present algebraic results concerning algebras of this type. Specifically, I will give a classification of simple modules and simple local modules of such an algebra. Using this classification, I will establish criteria for its category of local modules to be rigid, to have a non-degenerate braiding, to be ribbon, to have enough projective objects, and to be finite abelian. This talk is based on a joint work with Harshit Yadav.

Title and abstract (Dec 10)

1. Jehanne Dousse (University of Geneva): Perfect crystals and grounded partitions

A partition of a positive integer n is a non-increasing sequence of positive integers whose sum is n . These objects are classical in combinatorics and number theory, and since Lepowsky, Milne, and Wilson's seminal work in the 1980's, they are also related to the representation theory of affine Lie algebras. Indeed, after performing certain specialisations, the Weyl-Kac character formula allows one to express the character of an affine Lie algebra representation as the generating function for partitions with congruence conditions. However, while characters are, by definition, series with positive coefficients, it is not visible from the Weyl-Kac character formula.

Perfect crystals can be seen as oriented graphs containing the combinatorial information of representations, and they can also be used to give another expression of the characters thanks to the KMN^2 character formula. Primc initiated a connection between perfect crystals and partitions in the 1990's and deduced some partition identities.

In this talk, we will study the connection between perfect crystals and a refinement of partitions called grounded partitions, give a character formula as generating function for grounded partitions, and show that it can be used in two different ways:

- by combining it to the Weyl-Kac character formula, in order to obtain new partition identities
- by studying the combinatorics of the grounded partitions associated to a representation, to obtain manifestly positive character formulas.

This is joint work with Isaac Konan.

2. Kana Ito (Tsukuba University): Vertex operator realization of vacuum spaces for level 2 standard modules of type $A_n^{(2)}$
 Since Lepowsky-Wilson derived the Rogers–Ramanujan identities from the level 3 standard modules of type $A_1^{(1)}$, it has been expected that Rogers–Ramanujan type identities can be obtained from the principal characters of standard modules of affine Lie algebras. While the infinite product sides follow from character formulas, there is no general method for deriving the corresponding infinite sums. In some cases, the sum sides are obtained through vertex operator analysis. In this talk, we focus on the level 2 cases of type $A_n^{(2)}$, and describe a vertex operator realization of a generating set of the vacuum spaces.
3. Ole Warnaar (University of Queensland): q, t -Rogers–Ramanujan identities
 In this talk I will present a new type of Rogers–Ramanujan identity for affine Lie algebras that contains not just the usual parameter q but also a second “Hall–Littlewood” parameter t , while still admitting a product form. Our results naturally arise from conjectural affine analogues of the (dual) Jacobi–Trudi identities for symplectic and orthogonal characters. Specialisations of our results include the $A_{2n}^{(2)}$, $C_n^{(1)}$ and $D_{n+2}^{(2)}$ GOW identities.

Title and abstract (Dec 11)

1. Kazuo Habiro (University of Tokyo): Quasi-cellular categories and variants of the Brauer category
 Quasi-cellular categories are linear-categorical analogues of cellular algebras. A quasi-cellular category is a linear category equipped with a filtration on its objects together with upward, downward, and level subcategories endowed with a certain duality structure. For example, the Brauer, walled Brauer, partition, and Temperley-Lieb categories are quasi-cellular. I will discuss some basic properties and examples of quasi-cellular categories. This is joint work with Mai Katada.
2. Kazuhiro Hikami (Kyushu University): TBA
3. Yuya Murakami (RIKEN, iTHEMS): Quantum modularity and asymptotics for false theta functions and quantum invariants
 In this talk, I address two linked problems:
 - **Quantum topology:** Deriving asymptotic expansions of the Witten–Reshetikhin–Turaev invariants for a class of negative definite plumbed 3-manifolds,
 - **Number theory:** Establishing quantum modularity of false theta functions in full generality.
 For both problems, previous progress covers cases which rely on single integral representations. I extend previous results to cases for multiple integrals. To prove the results, I develop two techniques:
 - A Poisson summation formula with signature,
 - A framework of modular series.
 As further applications, my method yields a unified approach to proving quantum modularity for three typical examples of quantum modular forms:
 - False theta functions,
 - Indefinite theta functions,
 - Eisenstein series of odd weight.
4. Shoma Sugimoto (California Institute of Technology): An abelian categorification of \hat{Z} -invariants
 The \hat{Z} -invariant is a q -series valued quantum invariant for (negative definite plumbed) 3-manifolds introduced by Gukov–Pei–Putrov–Vafa in 2017. It provides not only a q -expansion of the Witten–Reshetikhin–Turaev invariant, but also rich examples of “spoiled” modular forms such as mock/false theta functions. The latter fact suggests the existence of non-rational vertex operator algebras (log VOAs) with \hat{Z} -invariants as their q -characters. However, the study of log VOAs is still underdeveloped, and no examples of such log VOAs have been found so far except for the two easiest cases: 3- or 4-leg star graphs. This talk will outline the “nested Feigin–Tipunin construction” introduced and developed by the speaker to provide a unified construction/research methodology of the above correspondence between log VOAs and (negative definite plumbed) 3-manifolds. It enables us to construct and study the abelian category of modules over the hypothetical log VOAs via the recursive application of the purely Lie algebraic geometric representation theory of FT

construction. In particular, the corresponding \hat{Z} -invariants are reconstructed in the Grothendieck group via the nested Weyl-type character formula. From a theoretical physics viewpoint, the nested FT construction can be regarded as the algebraic counterpart of the contribution from 3d $\mathcal{N} = 2$ theory in the \hat{Z} -invariants.

5. Toshiki Matsusaka (Kyushu University): On q -series identities from Lie superalgebras

In 1994, Kac and Wakimoto found the denominator identities for affine Lie superalgebras. As an application, they introduced an approach to derive power series identities for some powers of $\Delta(q)$, where $\Delta(q)$ is the generating function of triangular numbers. In this talk, we provide two different proofs of these identities. The first (and main) proof is analytic, relying on the modularity of q -series. In particular, the modularity is shown using the theory of indefinite theta functions developed by Roehrig and Zwegers. The second is algebraic, following the method of Kac and Wakimoto. This talk is based on joint work with Miyu Suzuki (Kyoto University).

Title and abstract (Dec 12)

1. Xuanzhong Dai (RIMS): Chiral differential operators on classical invariant rings

In this talk, we construct a sheaf of vertex operator algebras on the affine GIT quotient by BRST reduction, whose restrictions to its smooth subvariety coincide with the chiral differential operators associated to vector bundles constructed by Gorbounov, Malikov and Schechtman. We show that the global sections of these CDOs are always simple, and that the category of lower-bounded C_1 -cofinite modules is equivalent to the category of vector spaces. As an application, we calculate the associated varieties of three families of quasi-lisse vertex algebras obtained via quantum Hamiltonian reductions, and also obtained their free field realizations, including those of affine vertex algebras of \mathfrak{osp} -type. This is a joint work with Tomoyuki Arakawa and Bailin Song.

2. Tomoyuki Arakawa (RIMS): 3D N=4 Gauge Theory and Vertex Algebras

The Higgs branch and Coulomb branch of 3D N=4 gauge theory have attracted much attention from mathematicians since the work of Braverman–Finkelberg–Nakajima. On the other hand, Gaiotto introduced the A-twisted/B-twisted boundary VOAs as additional invariants of 3D N=4 gauge theory, which can be viewed as refinements of the Higgs and Coulomb branches. In this talk, I will begin with an overview of the expected properties of these VOAs and then discuss several examples.