ESI-Programmme on "Modern Trends in Topological Quantum Field Theory"

February 03 to March 28, 2014

Workshop II, March 17 -21, 2014 - Talks & Abstracts
(in alphabetical order of speakers, 6 pages):

Drazen Adamovic
On constructions of logarithmic representations for certain vertex algebras

In the first part of this talk I will present results and constructions on the representation theory of certain C2 cofinite vertex algebras and superalgebras appearing in logarithmic CFT (obtained jointly with A. Milas). A particular emphasis will be putÂ on the existence and explicit realizations of logarithmicÂ and indecomposable modules for affine vertex algebras and W-algebras of triplet type. We shallÂ also Â presentÂ various methods for studying representations of orbifold subalgebras of these vertex algebras.

John Barrett
The geometry of matrices and 2d TQFT

This talk discusses two distinct topics: Firstly, the non-commutative geometry of real spectral triples that have as algebra of coordinates the N x N matrices. Secondly, the extension of the Fukuma, Hosono and Kawai state sum models on surfaces to a framework that is sensitive to the spin structure of a surface. Finally I will discuss the question of what a "quantum geometry" is and propose some tentative relation between these two topics.

Christian Blanchet
Quantum invariants and spin structures

Non semi-simple sl(2) quantum invariants are defined for a root of unity whose order is 2r, for r>1 non zero mod 4. When r is zero mod 4, we define non semi-simple quantum invariants of 3-manifolds equipped with generalised spin structures.
We will give an overview of these generalised spin structures,explain the combinatorial descriptions in dimension 3 and describe semi-simple and non semi-simple quantum invariants involving these generalised spin structures.

Qingtao Chen
Congruent skein relation and LMOV conjectures

We obtain several very interesting congruent skein relations with the right motivation from studying the LMOV conjectures. When we applied this idea to colored Jones polynomials and su(n) invaraints, we also obtain a set of congruent skein relations for colored Jones polynomials and su(n) invariants.

Francesco Costantino
Non semi-simple sl(2) quantum invariants, Part 3:
TQFTs and mapping class group representations

This is the third talk of the sequence on non semi-simple Uqsl2 invariants. We will apply the universal construction to the non semi-simple invariants defined in the preceding talk to produce a new family of TQFTs indexed by integers r ≥ 2. We will first define the category of surfaces and their cobordisms to which the TQFT functor applies. Then we will discuss how the presence of a cohomology class in the whole picture enriches the resulting representation theory of mapping class groups and formulate some questions and conjectures concerning the properties of the obtained representations. In the last part of the talk we will discuss the main difficulties arising while applying the universal construction, how to overcome it and how these solutions provide new insights in the properties of the TQFTs.

(Joint work with C. Blanchet, N. Geer and B. Patureau)

Azat Gainutdinov
From the deformed Virasoro algebra to Temperley-Lieb algebras

Deformation of the infinite dimensional Lie algebra Virasoro resembles the well-known deformation of classical simple Lie algebras to quantum algebras. Such a deformation of the Virasoro algebra appeared to be useful in many applications to off-critical statistical models and massive integrable field theories. In the talk, I present my recent results on a surprising realization of this algebra in tensor products of N copies of the natural representation of the quantum group for sl(2). More formally, it turns out that the deformed Virasoro at Nth root of unity has representations realized by the Temperley-Lieb algebras with N generators. Such finite-dimensional representations are of the cyclic type (similar to those for quantum groups at roots of unity) and were never observed before. I will also discuss a limit when N goes to infinity and connection with conformal field theory.

Nathan Geer
Non semi-simple sl(2) quantum invariants,
Part I: From links to TQFTs

In the last few years, C. Blanchet, F. Costantino, B. Patureau, N. Reshetikhin, V. Turaev and myself (in various collaborations) have developed a theory of renormalized quantum invariants of links and 3-manifolds which lead to TQFTs. This talk will start out by giving an overview of this work.
In the second part of the talk I will discuss the renormalized quantum invariants of links coming from quantized sl(2) at a root of unity. These link invariants contain Kashaev's quantum dilogarithm invariants of knots, the Akutsu-Deguchi-Ohtsuki invariant of links and the multi-variable Alexander Polynomial. Moreover, these re-normalized invariants of knots are meromorphic functions whose residues are closely related to the the colored Jones polynomials.
The 3-manifold invariants and TQFTs associated to these link invariants will be discussed by B. Patureau and F. Costantino in two sequential talks.

Jesper Jacobsen
Logarithmic correlations in geometrical critical phenomena

In logarithmic conformal field theories (LCFT) correlation functions have their usual power-law behaviour modified by logarithms. The latter can be understood as originating from a resonance phenomenon between two or more operators with colliding critical exponents. In this setup LCFT are produced rather simply as appropriate limits of ordinary CFT. We show how the logarithmic couplings (also known as indecomposability parameters) can be computed from this limiting procedure. We also illustrate the ubiquity of LCFT in the statistical mechanics of geometrical critical phenomena. Logarithms appear as well in more than two dimensions. We illustrate this within the Potts model and its special cases, such as bond percolation. Simple representation theoretical tools are used to provide a clear geometrical interpretation of various logarithmic correlation functions. In particular we compute the logarithmic structure of two and three-point functions in arbitrary dimension.

Andrey Lazarev
Unimodular homotopy algebras and Chern-Simons theory

Quantum Chern-Simons invariants of differentiable manifolds are analyzed from the point of view of homological algebra. Given a manifold M and a Lie (or, more generally, an L-∞) algebra g, the vector space H*(M) \otimes g has the structure of an L-∞ algebra whose homotopy type is a homotopy invariant of M. We formulate necessary and sufficient conditions for this L-∞ algebra to have a quantum lift. We also obtain structural results on unimodular L-∞ algebras and introduce a doubling construction which links unimodular and cyclic L-∞ algebras.

(joint with C. Braun)

Gregor Masbaum
All finite groups are involved in the mapping class group

Let g be a positive integer and let Γg be the mapping class group of the genus g closed orientable surface. Ursula Hamenstädt in 2009 asked whether every finite group is involved in Γg. (Here a group G is said to be involved in a group Γ if G is isomorphic to a quotient of a subgroup of Γ of finite index.)
We use TQFT to answer Hamenstädt's question in the affirmative. The proof employs properties of the mapping class group representations coming from Integral SO(3)-TQFT.

(Joint work with A. Reid.)

Serguei Merkoulov
Grothendieck-Teichmueller group and exotic automorphisms of the Lie algebra of polyvector fields

Using some new operads of compactified semialgebraic configuration spaces, we show an explicit formula for a universal action of an element of the Grothendieck-Teichmueller group as a Lie-infinity automorphism of the Lie algebra of polyvector fields on an arbitrary smooth manifold.

Jun Murakami
Generalized Kashaev invariants for knots in three manifolds

Kashaev's invariants for a knot in a three sphere are generalized to invariants of a knot in a three manifold by combining the Hennings invariant of three manifolds and the logarithmic invariant of knots in a three sphere. A relation between the newly constructed invariants and the hyperbolic volume of the knot complement is observed for some knots in lens spaces.

Bertrand Patureau
Non semi-simple sl(2) quantum invariants, Part 2: 3-manifold invariants

This is the second talk of the sequence on non semi-simple Uqsl2 invariants. On the set of triplets (3-manifolds M, colored framed link L in M, degree 1 cohomology class on M\L) we can define two related families Nr and Nr0 of invariants indexed by the choice of the order 2r of a root of unity. They are both defined using modified trace and surgery presentations

following ideas of Reshetikhin and Turaev.
The first invariant Nr is only defined on a subset of admissible triplets (with a projective colored non empty link or a non integral cohomology class). It contains a generalization to arbitrary 3-manifolds of the Akutsu-Deguchi-Ohtsuki link invariant of link in S3. In particular, they give a version of the Kashaev link invariant for link in 3-manifold. The special case N2 is a canonical normalization of Reidemeister torsion.
The second invariant N0 is defined on any 3-manifold and is conjecturally proportional to the Witten-Reshetikhin-Turaev invariant.

(joint work with C. Blanchet, F. Costantino and N. Geer)

David Ridout
Module categories for affine VOAs at admissible level

The (simple) vacuum module of an affine Kac-Moody algebra is well known to admit the structure of a rational vertex operator algebra when the level is a non-negative integer. The simple VOA-modules then coincide with the integrable modules of the Kac-Moody algebra. This talk discusses recent progress in understanding the changes to that picture when the level is instead admissible (in the sense of Kac-Wakimoto).

Gregor Schaumann
*-representations for tensor categories

For *-algebras, the concept of a *-representation on an inner product module leads to the important notions of Rieffel induction and *-Morita equivalence. We present a categorified version of these concepts, with pivotal tensor categories instead of *-algebras and module categories with structual isomorphisms on their inner homs replacing the *-representations. Possible applications of these notions to oriented defects in TFTs are discussed.

Martin Schnabl
New look at BCFT's from OSFT

The classical solutions of Witten's open string field theory are believed to be in one-to-one correspondence with conformal boundary conditions for a given bulk 2d CFT. We shall explain the correspondence and present some novel implications for the structure of the conformal boundary states.

Christoph Schweigert
Invariants for mapping class group actions from ribbon Hopf algebra automorphisms

Lyubashenko's construction associates to a factorizable ribbon category representations of mapping class groups Map_{g,n} of Riemann surfaces of any genus g with any number n of holes. We consider this construction as applied to the category of bimodules over a finite-dimensional factorizable ribbon Hopf algebra H. For any such Hopf algebra (and a ribbon automorphism of it) we find an invariant of Map_{g,n} for all values of g and n.

Our results are motivated by the quest to understand correlation functions of bulk fields in two-dimensional conformal field theories with chiral algebras that are not necessarily semisimple, so-called logarithmic conformal field theories.

Simon Wood
Rational logarithmic extensions of the minimal models and their simple modules

The Virasoro minimal models admit C2 cofinite logarithmic extensions. In this talk I will review how they can be constructed as the kernels of screening operators acting on lattice vertex operator algebras; present explicit formulae for all Virasoro singular vectors in these theories; and explain how to use these singular vectors to compute relations in Zhu's algebra, which in turn allow one to classify all simple modules of the rational logarithmic extensions of the minimal models.