Program of the Conference "Higher algebra and mathematical physics", August 13 - 17, 2018

Monday, August 13, 2018

09:00 - 10:00	Registration
10:00 - 10:30	Christos Aravanis (University of Sheffield) On Hopf algebras and derived categories
10:30 - 11:00	Jian Qiu (Uppsala University) 4D exotic Donaldson-Witten theory from 5D super-Yang-Mills
11:00 - 11:30	Tea break (Tea Room 4th floor)
11:30 - 12:00	Chris Elliott (IHÉS) Topological Twists of Supersymmetric Factorization Algebras
12:00 - 15:00	Lunch break
15:00 - 15:10	Welcome and Opening Remarks (Scientific Organizers)
15:10 - 16:10	Davide Gaiotto* (Perimeter Institute) N=1 supersymmetric vertex algebras of small index
16:10 - 16:35	Tea break (Tea Room 4th floor)
16:35 - 17:35	Jörg Teschner (University of Hamburg) Geometric Langlands: Comparing the views from CFT and TQFT
17:35 - 18:00	Break
18:00 - 19:00	David Nadler* (UC Berkeley) Cutting and gluing branes
19:00 - 20:30	Break
20:30 - 22:00	Transatlantic informal discussions Seminar Room and 311 (free space 3rd floor)

Tuesday, August 14, 2018

10:00 - 11:00	Gong show
11:00 - 11:30	Tea break (Tea Room 4th floor)
11:30 - 12:00	Gong show
12:00 - 15:00	Lunch break
15:00 - 16:00	Bertrand Toën (Toulouse University) Moduli of connections on open varieties
16:00 - 16:30	Tea break (Tea Room 4th floor)
16:30 - 17:30	Lisa Jeffrey* (University of Toronto) The Duistermaat-Heckman distribution for the based loop group
17:30 - 18:00	Break
18:00 - 19:00	Damien Calaque (University of Montpellier) Vertex models and $\mathbb{E}_n$-algebras
19:00 - 23:00	Dinner (Tea Room 4th floor)

***Livestream from Perimeter Institute**

Wednesday, August 15, 2018

09:00 - 14:00	EXCURSION
14:00 - 15:00	LUNCH BREAK
15:00 - 16:00	ANDREW NEITZKE* (UT AUSTIN) Higher operations in supersymmetric field theory
16:00 - 16:30	TEA BREAK (TEA ROOM 4TH FLOOR)
16:30 - 17:30	LOTTE HOLLANDS (HERIOT-WATT UNIVERSITY) Spectral problems for the E6 Minahan-Nemeschansky theory
17:30 - 18:00	BREAK
18:00 - 19:00	MATILDE MARCOLLI* (PERIMETER INSTITUTE) Homotopy types and geometries below Spec($\mathbb{Z}$)
19:00 - 20:30	BREAK
20:30 - 22:00	TRANSATLANTIC INFORMAL DISCUSSIONS Seminar Room and 311 (free space 3rd floor)

Thursday, August 16, 2018

10:30 - 11:00	ALEXEI DAVYDOV (OHIO UNIVERSITY) Higher Witt categories of modular categories
11:00 - 11:30	TEA BREAK (TEA ROOM 4TH FLOOR)
11:30 - 12:00	SEVERIN BUNK (UNIVERSITÄT HAMBURG) Bundle Gerbes, D-Branes, and Smooth Open-Closed Field Theories
12:00 - 15:00	LUNCH BREAK
15:00 - 16:00	TOBIAS DYCKERHOFF (UNIVERSITY OF BONN) A categorified Dold-Kan correspondence
16:00 - 16:30	TEA BREAK (TEA ROOM 4TH FLOOR)
16:30 - 17:30	VALERIO TOLEDANO LAREDO* (NORTHEASTERN UNIVERSITY) Elliptic quantum groups and their finite-dimensional representations
17:30 - 18:00	BREAK
18:00 - 19:00	SYLVIE PAYCHA (UNIVERSITY OF POTSDAM) An algebraic locality principle to renormalise higher zeta functions
19:00 - 20:30	BREAK
20:30 - 22:00	TRANSATLANTIC INFORMAL DISCUSSIONS Seminar Room and 311 (free space 3rd floor)

***Livestream from Perimeter Institute**

Friday, August 17, 2018

10:30 - 11:00	LUKAS MÜLLER (HERIOT-WATT UNIVERSITY) Equivariant higher Hochschild homology and topological field theories
11:00 - 11:30	TEA BREAK (TEA ROOM 4TH FLOOR)
11:30 - 12:00	AUGUSTO STOFFEL (MPIM BONN) Geometric TQFTs and parallel transport
12:00 - 15:00	LUNCH BREAK
15:00 - 16:00	STEPHAN STOLZ* (UNIVERSITY OF NOTRE DAME) Invertible topological field theories are SKK manifold invariants
16:00 - 17:00	TEA BREAK (TEA ROOM 4TH FLOOR)
17:00 - 18:00	KATRIN WENDLAND (UNIVERSITY OF FREIBURG) A natural refinement of the Euler characteristic
18:00 - 20:00	BREAK
20:00 - 22:00	TRANSATLANTIC INFORMAL DISCUSSIONS Seminar Room and 311 (free space 3rd floor)

***Livestream from Perimeter Institute**

Conference "Higher algebra and mathematical physics", August 13 - 17, 2018

Titles and abstracts of talks

DAVIDE GAIOTTO

N=1 supersymmetric vertex algebras of small index

I will describe examples of holomorphic N=1 super-symmetric vertex algebras with small (non-zero) values of the elliptic genus. I will speculate on a relation to certain patterns in the theory of topological modular forms.

JÖRG TESCHNER

Geometric Langlands: Comparing the views from CFT and TQFT

The goal of my talk will be to discuss the relation between two approaches to the geometric Langlands program. The first has been proposed by Beilinson and Drinfeld, using ideas and methods from conformal field theory (CFT). The second was initiated by Kapustin and Witten based on a topological version of four-dimensional maximally supersymmetric Yang-Mills theory and its reduction to a two-dimensional topological sigma model. After discussing some issues complicating a direct comparison we will formulate a proposal for a precise relation between two main ingredients in the two approaches.

DAVID NADLER

Cutting and gluing branes

I'll discuss some results and expectations about the behavior of branes in Betti geometric Langlands under cutting and gluing Riemann surfaces.

BERTRAND TOËN

Moduli of connections on open varieties

This is a join work with T. Pantev. In this talk, we will discuss moduli of flat bundles on smooth algebraic varieties, with possibly irregular singularities at infinity. For this, we use the notion of "formal boundary", previously studied by Ben Bassat-Temkin, Efimov and Hennion-Porta-Vezzosi, as well as the moduli of flat bundles at infinity. We prove that the fibers of the restriction map to infinity are representable. We also prove that this restriction map has a canonical Lagrangian structure in the sense of shifted symplectic geometry.

LISA JEFFREY

The Duistermaat-Heckman distribution for the based loop group

The based loop group is an infinite-dimensional manifold equipped with a Hamiltonian action of a finite dimensional torus. This was studied by Atiyah and Pressley. We investigate the Duistermaat-Heckman distribution using the theory of hyperfunctions. In applications involving Hamiltonian actions on infinite-dimensional manifolds, this theory is necessary to accommodate the existence of the infinite order differential operators which aries from the isotropy representation on the tangent spaces to fixed points. (Joint work with James Mracek)

DAMIEN CALAQUE

Vertex models and $\mathbb{E}_n$-algebras

I will explain and state a conjecture of Kontsevich, that relates vertex models from statistical mechanics to $\mathbb{E}_n$-algebras. I will also give the main ingredients of the proof of Kontsevich's conjecture, which is a joint work in progress with Damien Lejay.

ANDREW NEITZKE

Higher operations in supersymmetric field theory

Various recent developments, in particular in the context of topological Fukaya categories, seem to be glimpses of an emerging theory of categorified homotopical and homological algebra. The increasing number of meaningful examples and constructions make it desirable to develop such a theory systematically. In this talk, we discuss a step towards this goal: a categorification of the classical Dold–Kan correspondence.

LOTTE HOLLANDS

Spectral problems for the E6 Minahan-Nemeschansky theory

According to Nekrasov and Shatashvili the Coulomb vacua of four-dimensional N=2 theories of "class S", subjected to the Omega background in two of the four dimensions, correspond to the eigenstates of a quantisation of the Hitchin integrable system. The vacua may be found as the intersection between two Lagrangian branes in the Hitchin moduli space, one of which is the space of opers (or quantum Hamiltonians) and one is defined in terms of a system of Darboux coordinates on the corresponding moduli space of flat connections. I will introduce such a system of Darboux coordinates on the moduli space of SL(3) flat connections on the three-punctured sphere through a procedure called abelianization and describe the spectral problem characterising the corresponding quantum Hitchin system. This talk is based on work to appear with Andrew Neitzke.

MATILDE MARCOLLI

Homotopy types and geometries below Spec$(\mathbb{Z})$

This talk is based on joint work with Yuri Manin. The idea of a "geometry over the field with one element $\mathbb{F}_1$" arises in connection with the study of properties of zeta functions of varieties defined over $\mathbb{Z}$. Several different versions of $\mathbb{F}_1$ geometry (geometry below Spec$(\mathbb{Z})$) have been proposed over the years (by Tits, Manin, Deninger, Kapranov-Smirnov, etc.) including the use of homotopy theoretic methods and "brave new algebra" of ring spectra (Toën-Vaquié). We present a version of $\mathbb{F}_1$ geometry that connects the homotopy theoretic viewpoint, using Zakharevich's approach to the construction of spectra via assembler categories, and a point of view based on the Bost–Connes quantum statistical mechanical system, and we discuss its relevance in the context of counting problems, zeta-functions and generalised scissors congruences.

TOBIAS DYCKERHOFF

A categorified Dold-Kan correspondence

Various recent developments, in particular in the context of topological Fukaya categories, seem to be glimpses of an emerging theory of categorified homotopical and homological algebra. The increasing number of meaningful examples and constructions make it desirable to develop such a theory systematically. In this talk, we discuss a step towards this goal: a categorification of the classical Dold-Kan correspondence.

VALERIO TOLEDANO LAREDO

Elliptic quantum groups and their finite-dimensional representations

I will describe joint work with Sachin Gautam where we give a definition of the category of finite-dimensional representations of an elliptic quantum group which is intrinsic, uniform for all Lie types, and valid for numerical values of the deformation and elliptic parameters. We also classify simple objects in this category in terms of elliptic Drinfeld polynomials. This classification is new even for $\mathfrak{sl}(2)$, as is our definition outside of type A.

SYLVIE PAYCHA

An algebraic locality principle to renormalise higher zeta functions

According to the principle of locality in physics, events taking place at different locations should behave independently of each other, a feature expected to be reflected in the measurements. We propose an algebraic locality framework to keep track of the independence, where sets are equipped with a binary symmetric relation we call a locality relation on the set, this giving rise to a locality set category. In this algebraic locality setup, we implement a multivariate regularisation, which gives rise to multivariate meromorphic functions. In this case, independence of events is reflected in the fact that the multivariate meromorphic functions involve independent sets of variables.A minimal subtraction scheme defined in terms of a projection map onto the holomorphic part then yields renormalised values. This multivariate approach can be implemented to renormalise at poles, various higher multizeta functions such as conical zeta functions (discrete sums on convex cones) and branched zeta functions (discrete sums associated with rooted trees).This renormalisation scheme strongly relies on the fact that the maps we are renormalizing can be viewed as locality algebra morphisms. This talk is based on joint work with Pierre Clavier, Li Guo and Bin Zhang.

STEPHAN STOLZ

Invertible topological field theories are SKK manifold invariants

Topological field theories in the sense of Atiyah-Segal are symmetric monoidal functors from a bordism category to the category of complex (super) vector spaces. A field theory E of dimension d associates vector spaces to closed (d-1)-manifolds and linear maps to manifolds of dimension d. It turns out that if E is invertible, i.e., if the vector spaces associated to (d-1)-manifolds have dimension one, then the complex number E(M) that E associates to a closed d-manifold M, is an SKK manifold invariant. Here these letters stand for schneiden=cut, kleben=glue and kontrolliert=controlled, meaning that E(M) does not change when modifying the manifold by cutting and gluing along hypersurfaces in a controlled way. The main result of this joint work with Matthias Kreck and Peter Teichner is that the map described above gives a bijection between topological field theories and SKK manifold invariants.

KATRIN WENDLAND

A natural refinement of the Euler characteristic

The Euler characteristic of a compact complex manifold M is a classical cohomological invariant. Depending on the viewpoint, it is most natural to interpret it as an index of an elliptic differential operator on M, or as a supersymmetric index in superconformal field theories “on M”. Refining the Euler characteristic but keeping with both index theoretic interpretations, one arrives at the notion of complex elliptic genera. We argue that superconformal field theory motivates further refinements of these elliptic genera which result in a choice of several new invariants, all of which have lost their interpretation in terms of index theory. However, at least if M is a K3 surface, then superconformal field theory and higher algebra select the same new invariant as a natural refinement of the complex elliptic genus.

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Titles and abstracts of contributed talks

CHRISTOS ARAVANIS

On Hopf algebras and derived categories

Rozansky-Witten theory is a physical 3d TQFT which depends on a Hyperkähler manifold. Roberts and Willerton studying topics related to the partition function of this theory highlighted the relevance of the derived category of coherent sheaves on the Hyperkähler manifold. In this talk, I will discuss the Hopf algebra object in the derived category of coherent sheaves motivated by a rigorous construction of an extended TQFT forRozansky-Witten theory.

JIAN QIU

4D exotic Donaldson-Witten theory from 5D super-Yang-Mills

In this talk I shall describe an ongoing joint project with Festuccia, Winding and Zabzine, aiming at generalizing the Donaldson-Witten theory in a natural way. The DW theory computes integrals of certain characteristic classes over the moduli space of anti-self-dual Yang-Mills instantons. We attempt to generalize it in two directions. First, the instanton configuration $F^+ = 0$ (where F is the Yang-Mills field strength) is generalized to $PF = 0$, where P is a projector projecting F to a rank 3 sub-bundle of 2-forms. Second, we add equivariance. In the case of DW theory over compact space, equivariance is not strictly necessary, but for our generalization, it is crucial for having a good moduli problem. Physically, our theory can be obtained from reducing a 5D Super Yang-Mills theory to 4D along a circle fibration, and so has a natural description in 5D terms. But describing it in purely 4D terms is also rewarding, in that it is a an extension of the super Yang-Mills theory over S^4, constructed by Pestun. Localization can be likewise carried out leading to interesting special functions and allowing us to explore the geometry of the underlying space.

CHRIS ELLIOTT

Topological Twists of Supersymmetric Factorization Algebras

The idea of topologically twisting a supersymmetric field theory was introduced in the physics literature in order to generate interesting new examples of topological field theories. The idea is very general, but systematically realising the examples it produces using mathematical models for topological quantum field theory (such as the functorial axioms of Atiyah-Segal or the theory of E_n-algebras) is not always possible. In this talk I'll explain what it means to twist a supersymmetric field theory in the factorization algebra framework developed by Costello and Gwilliam, and address the question of just how topological these topologically twisted theories really are. This is based on joint work with Pavel Safronov.

ALEXEI DAVYDOV

Higher Witt categories of modular categories

Higher category structure of defects in 3D TFTs and 2D RCFTs indicates existence of a 3-category with modular fusion categories as objects. This 3-category provides a higher categorification of the Witt group of modular categories.

SEVERIN BUNK

Bundle Gerbes, D-Branes, and Smooth Open-Closed Field Theories

Bundle gerbes are the geometric objects which describe B-fields in string theory. Their sections, in turn, are the (twisted) Chan-Paton bundles that model the K-theory charges of D-branes. While this describes the topological part of a spacetime geometry in string theory, the configuration space of strings consists of loop and path spaces. On these spaces, the same geometry takes a different form; we show that it translates to bundles of algebras and bimodules that generalise coloured, knowledgeable Frobenius algebras. From a yet different perspective, the perturbative interactions of strings are encoded in a smooth, open-closed functorial field theory on the background manifold.In this talk, based on a collaboration with Konrad Waldorf, we will employ the 2-categorical structure of bundle gerbes to provide concrete constructions that relate the spacetime, path space, and functorial field theory perspectives on B-fields and D-branes in bosonic string theory.

LUKAS MÜLLER

Equivariant higher Hochschild homology and topological field theories

We present a version of higher Hochschild homology for spaces equipped with principal G-bundles. As coefficients we allow E_∞-algebras with G-action. For this homology theory we establish an equivariant version of excision to prove that it extends to an equivariant topological field theory with values in the $(\infty, 1)$-category of co-spans in E_∞-algebras. As an example we construct equivariant Dijkgraaf-Witten theories. This is joint work in progress with Lukas Woike.

AUGUSTO STOFFEL

Geometric TQFTs and parallel transport

I will discuss a definition of bordism categories where bordisms are equipped with general geometric structures. This is motivated by applications such as the representation of cohomology theories through field theories. Then I will discuss the case of 1-dimensional TQFTs over a manifold X. It turns out, as one would hope, that these are nothing but vector bundles with connection over X. I'll explain how the difficulties entailed in this statement and their resolution are related to the problem of representing cohomology theories. This is joint work with Matthias Ludewig and Stephan Stolz.