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ABSTRACTS

Workshop on "The interrelation between mathematical physics, number theory and noncommutative geometry", Research Meeting, March 9 - 13, 2015:

Katarzyna Rejzner
BV algebras in perturbative AQFT and effective quantum gravity

Perturbative algebraic QFT is a mathematically rigorous framework which allows to study foundations of perturbative QFT. In this talk I will explain how BV algebras arise naturally in this construction. The physical motivation ins quantization of gauge theories and recently these methods were applied also in perturbative quantum gravity. Mathematically, the construction which I present allows to make an interesting connection between functional analytic methods of infinite dimensional differential geometry and homological algebra.

Sylvie Paycha
The residue of meromorphic functions with linear poles and the geometry of cones. (based on joint work with Li Guo and Bin Zhang)

Germs of meromorphic functions with linear poles at zero naturally arise in various contexts in mathematics and physics. We provide a decomposition of the algebra of such germs into the holomorphic part and a linear complement by means of an inner product using our results on cones and associated fractions in an essential way. Using this decomposition, we generalize the graded residue on germs of meromorphic functions in one variable to a graded residue on germs of meromorphic fractions in several variables with linear poles at zero and prove that it is independent of the chosen inner product. When this residue is applied to exponential discrete sums on lattice cones, we obtain exponential integrals, giving a first relation between exponential sums and exponential integrals on lattice cones. On the other hand, this decomposition of meromorphic germs also provides a key ingredient in the Birkhoff-Hopf type factorization through which we revisited Berline and Vergne's Euler-Maclaurin formula on lattice cones, establishing another relation between exponential sums and integrals.

Jacob Bourjaily
tba

Susama Agarwala
A Tale of two renormalizations: BPHZ and Epstein Glaser

In this talk I consider two different approaches to renormalization: BPHZ, and Epstein Glaser. Recent activity has assigned apparently very different Hopf algebraic structures to the two approaches. I show that these apparently divergent approaches are, in fact, combinatorially the same.

David Broadhurst The Open University, UK
Polylogs of roots of unity: the good, the bad and the ugly

I shall discuss enumerations, by weight and by depth, of irreducible multiple polylogarithms of Nth toots of unity. Quantum field theory already requires us to study N=1,2,6. Mathematically speaking, the good cases are N=2,3,4,6,8, for all of which I shall give compelling conjectures for concrete sets of irreducibles. The bad case of multiple zeta values, with N=1, is covered by the Broadhurst-Kreimer conjecture, which enumerates irreducibles but makes it very hard to choose them. I shall give recent evidence that the cases N=5,7 are neither good nor bad, but just plain ugly.

Dirk Kreimer
Organizing QFT by next to leading logs

I will review how one can use the algebraic structures of Feynman diagrams and Dyson Schwinger equations to find differential equations for next to leading log expansions. This includes an analysis of the structure of Dyson–Schwinger equations, the equations of motion for the Green functions in QFT. This is joint work with Spencer Bloch and Karen Yeats, and with Olaf Krueger."

Vincent Rivasseau (Orsay)
Tensor Models, from branched polymers to Brownian spheres

Ordinary tensor models of rank D = 3 are dominated at large N by tree-like graphs, known as melonic triangulations. We shall show that non-melonic contributions can be enhanced consistently, leading to different types of large N limits. For instance the most generic quartic tensor model at rank 4, with maximally enhanced non-melonic interactions, displays a branched polymer phase and a 2D quantum gravity phase, and a transition between them whose entropy exponent is positive. This work is in collaboration with V. Bonzom and T. Delepouve.

Nils Carqueville (Simons Junior Professor), speaks in the Mathematical Colloquium on 11 th of March, 15:15 Uhr, in the Lounge, 12. floor, building of the Faculty of Mathematics, Oskar-Morgenstern-Platz 1, on:

Topological quantum field theory: symmetries and defects

A major paradigm of 20th-century science is to understand nature in the language of quantum field theory. Efforts to make mathematical sense of this language have led to successful and ongoing cross-fertilisation between theoretical physics and pure mathematics. In particular, Atiyah and Segal proposed an axiomisation of the notorious path integral"by beautifully linking geometry with algebra. The talk starts with a lightening review of this functorial approach, and then quickly restricts to the case in which spacetime is two-dimensional and has no geometric structure: two-dimensional topological quantum field theory (TQFT). This seemingly simple situation is still surprisingly rich, and we will see how algebras, categories, and "higherßtructures appear naturally; examples of such structures are ubiquitous in many areas of mathematics. Once the stage is carefully set, we turn to the central notion of symmetry, which involves the action of groups on a TQFT. We will be led to interpret symmetries as special kinds of "defectsöf the TQFT, which in turn allows for a natural, purely algebraic generalisation of the operation of modding out by a symmetry". This leads to new equivalences between categories, which we will illustrate with examples from singularity theory and representation theory.

Thomas Krajewski (Marseille)
Some applications of the loop vertex expansion

Most of the pertubative expansions of quantum field theories lead to divergent asymptotic series in the coupling constant. We will review an alternative to the Feynman graphs expansion based on trees, known as the loop vertex expansion. We will also present some applications of the loop vertex expansion to matrix models (work in collaboration with R. Gurau)

Adrian Tanasa

Tensor models

Tensor models, seen as quantum field theoretical models, represent a natural generalization of the celebrated 2-dimensional matrix models. These matrix models are known to be connected to various domains of both mathematics and theoretical physics. One of the main results of the study of matrix models is that their perturbative series can be reorganized in powers of 1/N (N being the matrix size). The leading order in this expansion is given by planar graphs (which are dual to triangulations of the 2-dimensional sphere S^2). In this talk I will present such a 1/N expansion for some particular class of 3-dimensional tensor models. The leading order (and hence the dominant graphs, dual to particular triangulations of the three-dimensional sphere S^3), the next-to-leading order and finally some considerations on the combinatorics of the general term of this expansion will be given.

Victor Gayral
From equivariant quantization to locally compact quantum group ¡https://www.youtube.com/watch?v=xrfnjjtztkI¿

The goal of this talk is to explain how non-formal equivariant quantization gives rise to concrete examples of locally compact quantum groups, via the explicit construction of dual unitary 2-cocycles and of multiplicative unitaries. I will start to explain the general strategy and then give three classes of examples: the negatively curved Khlerian Lie groups, some p-adic groups and some non-geometric examples.

Giovanni Landi, University of Trieste, Italy
The geometry of quantum lens spaces

We define quantum lens spaces as 'direct sums of line bundles' and exhibit them as 'total spaces' of certain principal bundles over quantum weighted projective spaces. For each quantum lens space we construct an analogue of the classical Gysin sequence. We use the sequence to compute the K-theory and the K-homology of the quantum lens spaces, in particular to give explicit geometric representatives of their K-theory classes. These representatives are interpreted as 'line bundles' and generically define 'torsion classes'. We work out explicit examples of these classes.

Lars Hesselholt
Topological Hochschild homology and periodicity.

In this talk, I will explain the calculation of the topological Hochschild homology and the related theories TR, TF, and TC of the valuation ring in the perfectoid field of p-adic complex numbers. As a consequence of this calculation, one obtains, for any algebra over this ring, a periodicity operator similar to Connes' S-operator in cyclic homology.

Spencer Bloch
Cutkosky rules and vanishing cycles

The physical concept of dispersion is closely related to the Picard Lefschetz transformation in mathematics. The Cutkosky picture of putting edges on shell is plausible mathematically only if certain real symmetric matrices are positive definite. I will explain and discuss recent computations. This is joint work with Dirk Kreimer.

Dmitry Doryn
Counting rational points on graph hypersurfaces

I will summarize what we know about the number of $\mathbb{F}_q$-rational points on the hypersurfaces related to Feynman graphs and about the c_2 invariant.