Geometry and Renormalisation

26-30 September 2022, University of Potsdam

Titles and abstracts

Paolo Aschieri (Alessandria and Torino)

Title: *Noncommutative Riemannian geometry*
Abstract: Motivated by the formulation of a gravity theory in noncommutative spacetime we study the Levi Civita connection associated with an arbitrary (dynamical) noncommutative metric tensor. The problem is solved for spacetimes that are braided commutative (like homogenous spaces of triangular quantum groups). Then more general noncommutative manifolds like quantum groups are considered and the Levi-Civita connection presented for a class of metrics.

Marko Berghoff (Berlin)

Title: *Analytic structure of scattering amplitudes*

Abstract: Our understanding of scattering amplitudes is often hindered by the inability to solve the corresponding integrals. Nevertheless, or rather because of this, there exist powerful methods to study their analytic structure without solving them explicitly. In this talk I will review one such method based on Picard-Lefschetz theory. This framework (going back to work of Leray and Pham et al.) allows to study a large class of parameter-dependent integrals (e.g. scattering amplitudes) by methods from singularity theory/differential topology. I will demonstrate how a careful analysis of singularity types leads to a fairly general vanishing statement for iterated variations/discontinuities and how this demystifies the "principle of hierarchies" from 1960's S-Matrix theory.

This is joint work with Erik Panzer (University of Oxford)

Jurco Brano (Prague)

Title: *On the category of BV-theories (aka quantum L-infinity algebras)*

Abstract: We propose an enhancement of (odd) sympelctic category (in the spirit of Severa and Weinstein) and discuss its relation to homological perturbation theory.

Pierre Clavier (Mulhouse)

Title: *A Hopf algebra of resurgent functions*
Abstract: Resurgent functions play an important role in the Borel-Ecalle method of resummation of divergent series appearing in particular in dynamical systems and physics. Recently, Borinsky and Dunne pointed out an issue with the standard approach to the Borel-Ecalle resummation method when applied to quantum field theory. This non-technical introductory talk will be about an ongoing research project. I will explain how one can use the methods of Ecalle's mould calculus to define a coproduct on resurgent functions which, with their natural convolution product, endows them with a bialgebra (then a Hopf algebra) structure. This construction essentially relies on the notion of resurgence monomials.

Carlo Alberto Cremonini (Prague)

Title: *Lie superalgebra cohomology and (perhaps) new branes*
Abstract: Motivated by the construction of new higher-WZW and, possibly, new supergravity sources, we will discuss some aspects of Lie superalgebra cohomology in the sectors of pseudoforms. We will emphasise the infinite-dimensional nature of the representations defining such new cohomology classes and the differences with the finite-dimensional case. We will comment on some work-in-progress regarding the physical models that can be constructed out of these new objects, inspired by GS strings and doubly-supersymmetric strings.

Kurusch Ebrahimi-Fard (Trondheim)

Title: *Cumulants in algebra and probability*
Abstract: We will discuss the notion of cumulants in the context of algebra and probability theory. This includes on the one hand the algebraic structure underlying a manifold with a general affine connection, where we try to understand the relations between the Magnus expansion, the Grossman-Larson product and A.V. Gavrilov's double-exponential. On the other hand, we will discuss Wick polynomials and their role in renormalisation.

Léonard Ferdinand (Paris-Saclay)

Title: *Borel summability of the 1/N quartic expansion in O(N)-vector models*

Abstract: We consider a quartic O(N) -vector model in dimension 0. Using Loop Vertex Expansion, we prove Borel summability in 1/N along the real axis of the free energy and of the connected correlations. These results are to be compared with those obtained by Billionnet and Renouard in 82, where they just prove BS of the free energy and the moments, but in a 2 dimensional setting.

Based on joint work with Fabien Vignes-Tourneret, Razvan Gurau and Carlos Perez-Sanchez

Razvan Gurau (Heidelberg)

Title: *Old and new on random tensors*

Abstract: The latest addition to the family of large N field theories is tensor field theory built on the melonic large N limit of random tensors. This large N limit is richer than the vector large N limit but more amenable to analytic computations that the planar one. In this talk I will present an overview of the main results obtained on tensor field theories over the past several years and comment on their implications for the future.

Estanislao Herscovich (Grenoble)

Title: *2-monoidal categories in quantum field theory*

Abstract: The aim of this talk is to present a more unified approach to some algebraic structures appearing in the formulation of quantum field theory (QFT) by R. Borcherds. They are naturally described using 2-monoidal categories of functors, in a very similar language to that of vertex algebras also proposed by Borcherds. Furthermore, we also introduce some partial algebraic structures which naturally appear when dealing spaces of distributions and that seem to be pervasive in QFT.

Larisa Jonke (Zagreb)

Title: *Generalized symmetries as homotopy Lie algebras*

Abstract: In this talk we discuss two examples of generalized gauge symmetries formulated in terms of the homotopy Lie algebras. One example will be used to discuss the relation between homotopy Lie algebras, BV formalism and graded differential geometry, while the other example will focus on the relation to Hopf algebras. If time permits I will also sketch the construction of classical field theories with given generalized gauge symmetries.

Frédéric Patras (Nice)

Title: *Combinatorial formulas for pre-Lie algebras*
Abstract : The pre-Lie algebra structure of Feynman graphs allows to extend the pQFT Zimmermann forest formula to a general formula for antipodes in enveloping algebras of preLie algebras. We discuss in this presentation the generalization of these ideas to other combinatorial phenomena in these enveloping algebras, with a focus on Magnus formulas. Based on joint works with F. Menous and A. Celestino.

Kasia Rejzner (York)

Title: *A new perspective on the Wess-Zumino consistency condition*

Abstract: In this talk I will present some recent results obtained in collaboration with Brunetti, Duetsch and Fredenhagen, concerning the interplay between symmetries and renormalization in a new approach to constructing QFT models. In particular, I will focus on the geometrical meaning of anomalies and some consistency relations that they need to satisfy.

Ludwig Rahm (Trondheim)
Title: Renormalisation of rough paths in homogeneous spaces

Abstract: Branched rough paths have been used to solve stochastic differential equations in Euclidean spaces. This talk is based on a generalisation of the notion of a branched rough path to that of a planarly branched rough path, for solving stochastic differential equations on homogeneous spaces. The main focus of the talk will then be on translations of planarly branched rough paths, which is a notion closely related to renormalisation of rough paths. We define the translation map and give a combinatorial description of the dual map as a coaction on

planar forests. We furthermore present a notion of translations of rough paths in any combinatorial Hopf algebra, based on bialgebras in cointeraction.

Adrian Celestino Rodriguez (Trondheim)

Title: *Monotone cumulant-moment formula and Schröder trees*.
Abstract: In non-commutative probability, the notions of free, Boolean and monotone independence can be understood as rules to compute mixed moments. For each notion of independence, the respective cumulants can be defined via combinatorial formulas based on the lattices of non-crossing and interval partitions. In this talk, we will explain the latter and focus on the problem of expressing with a closed combinatorial formula multivariate monotone cumulants in terms of products of moments. The approach is based on two Hopf algebra structures, one in terms of words and the other in terms of Schröder trees, that describe the relations between moments and cumulants. In the process, we find specific coefficients appearing in the context of the pre-Lie Magnus' expansion of the generator of the pre-Lie algebra of rooted trees. Based on joint work with Octavio Arizmendi (arXiv:2111.02179).

Adrian Tanasa (Bordeaux)

Title: *Tensor models, large N limit and double scaling limit*
Abstract: Tensor models are a natural quantum field theoretical candidate for a theory of random geometries in dimension higher than 2.
Tensor models can also be seen as a generalization of the celebrated matrix models, intensively studied in both mathematics and theoretical physics. Among some of the most important results
in the study of matrix models in mathematical physics, one can name the large N limit and the double scaling limit mechanisms.
In this talk I will focus on two particular tensor models, the so-called multi-orientable and the O(N)^3-invariant models, and I will present the implementation of these two mechanisms, the large N limit and the double scaling limit mechanism.

Dang Nguyen Viet (Sorbonne Unversité)

Title: *Some recent progress on the construction of quantum fields on Riemannian 3-manifolds.*
Abstract: I will report on joint work in progress with Ismael Bailleul, To Tat Dat, Léonard Ferdinand, Fabien Vignes Tourneret on the construction of quantum fields on compact Riemannian 3 manifolds.

Fabien Vignes-Tourneret (Lyon)

Title: *Constructive Tensors*

Abstract: Random tensors provide a nice way of summing over discretised metric spaces. Their non-perturbative study has been made possible by new constructive tools developed originally by Vincent Rivasseau 15 years ago. This talk will be an introduction to the methods and results of constructive tensor field theory.