Abstracts

Benedetti, **Bruno** - *Local constructions of manifolds*

"Locally constructible" (LC) triangulations of manifolds are those obtainable from a tree of d-simplices, by repeatedly glueing two adjacent boundary facets. The notion was introduced in 1995 by Durhuus and Jonsson, for asymptotic counts needed in discrete quantum gravity. (LC triangulations are exponentially many, in fixed dimension, in terms of the number of facets.) Durhuus and Jonsson conjectured that all triangulations of spheres (and perhaps of all simply connected manifolds) are LC.

The conjecture was solved in the negative by Ziegler and me in 2011; we showed that many triangulations of the 3-sphere are not LC. However, there is some positive news, namely, every triangulation of every simply connected manifold (except in dimension 4) does admit an LC subdivision, which can be found via repeated barycentric subdivisions.

This is partly based on joint work with Günter Ziegler and Karim Adiprasito.

Collins, **Benoît** - *(Random) Tensors and (asymptotic) freeness*

This talk will be a review of techniques arising from free probability theory, allowing to understand the joint behaviour of multiple copies of random tensors. We will also mention recent applications of the so-called linearization trick and Weingarten calculus in the context of random tensors. Part of this talk is joint work with Camille Male (CNRS Paris 5) and Pierre Yves Gaudreau Lamarre (Ottawa).

Dittrich, **Bianca** - *Quantum Spacetime Engineering*

Given (a set of) fundamental models of quantum space time, for instance spin foam models, we aim to understand the large scale physics encoded in these fundamental models. Renormalization and coarse graining address this issue and help to understand how large scale physics depends on parameters in the fundamental models.

I will review recent work on coarse graining and renormalization of spin foams, revealing possible large scale phases, depending on parameters of the microscopic models. I will explain how these phases are connected to topological field theories and possible vacua for the theory of quantum gravity, e.g. loop quantum gravity.

I will also explain how these considerations led to an introduction of a new representation for loop quantum gravity, for which the topological BF phase acts as a vacuum, and in which Wilson surfaces, rather than Wilson loops, play the fundamental role.

Eckmann, **Jean-Pierre** - *The dynamics of* 2*d- and* 3*d-topological glasses*

I will give an overview of what I know about purely topological glasses in 2 and 3 dimensions. This is work with Maher Younan and Pierre Collet. While the 2-dimensional case is fairly well understood, already the definition of a reasonable model in 3 dimensions is difficult. But at least a careful definition of local energy allows one to observe a glass-like behavior for the return to equilibrium.

Grosse, **Harald** - *Exact solution of a four dimensional field theory*

Together with Raimar Wulkenhaar we showed that the quartic matrix model with an external matrix is exactly solvable in terms of the solution of a non-linear equation and the eigenvalues of that matrix. The selfcoupled scalar model on Moyal space is of this type, and our solution leads to the construction of the Schwinger functions. After taking a suitable limit the model satisfies growth properties, covariance and symmetry and there is numerical evidence for reflection positivity of the 2-point function for a certain range of the coupling constant.

Gurau, **Razvan** - *Tensor Models in the Large N limit*

Tensor models generalize matrix models and provide a framework for the study of random geometries in arbitrary dimensions. Like matrix models they support a $1/N$ expansion, where N is the size of the tensor, with an analytically controlled large N limit. In this talk I will present some recent results in this field and I will discuss their implications.

Kahle, **Matthew** - *Phase transitions for homology in random simplicial complexes*

We will overview the topology of random simplicial complexes, especially focusing on recent techniques. Garland's method allows one to reduce certain problems in stochastic topology to questions about spectral gaps of certain random matrices. Combining with new results on the spectrum of Erdős–Rényi random graphs, this allows one to establish sharp thresholds for homology vanishing for various models of random simplicial complexes. This is joint work with Christopher Hoffman and Elliot Paquette.

Kalfagianni, **Efstratia** - *State surfaces in quantum and geometric topology*

State surfaces are spanning surfaces of knots that are built from knot diagrams. We will discuss how state surfaces can be used to study Jones type polynomial knot invariants and understand some of the geometric properties of knot complements they detect.

Koutschan, **Christoph** - *On the AJ conjecture of connected sums of knots*

In knot theory, the AJ conjecture states a close connection between the A-polynomial of a knot K and the q-recurrence equation that the colored Jones function of K satisfies. After introducing these concepts, we show that verifying the AJ conjecture for specific knots naturally leads to the problem of factoring q-shift operators. We discuss some improvements on existing factorization algorithms, their implementation and application to knots with few crossings and their connected sums. This is joint work with S. Garoufalidis.

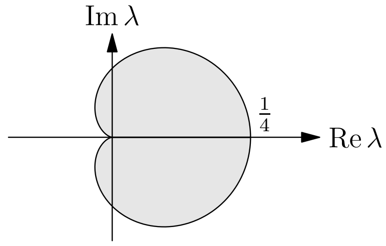
Krajewski, **Thomas** - *Analycity results for the cumulants in a quartic matrix model*

The cumulants in the matrix model we consider are defined through their generating function

$$\log \int dM \exp\left\{ -\mathrm{Tr}(MM^\dagger) - \frac{\lambda}{2N}\mathrm{Tr}(MM^\dagger MM^\dagger) + \sqrt{N}\mathrm{Tr}(JM^\dagger) + \sqrt{N}\mathrm{Tr}(MJ^\dagger) \right\}$$

with M a complex $N \times N$ matrix. Using the Loop Vertex Expansion, we show that the cumulants can be written as a convergent series over trees inside the cardioid

$$\mathcal{C} = \left\{ \lambda \in \mathbb{C} \quad \text{with} \quad 4|\lambda| < \cos^2\left(\frac{\arg\lambda}{2}\right) \right\}$$



Finally, we also derive convergent expansions and bounds for the remainders of the perturbative series (graphs up to fixed order) and topological series (graphs up to fixed genus). This is work in collaboration with R. Gurau (Ecole Polytechnique).

Loll, **Renate** - *Causal structure and time in (generalized) CDT quantum gravity*

Causal Dynamical Triangulations (CDT) is a concrete realization of trying to define a theory of nonperturbative quantum gravity as a "sum over histories". At an intermediate step, spacetime histories and their intrinsic curvature properties are encoded into triangulated, piecewise flat manifolds, with geometry encoded into connectivity data. A major insight provided by CDT is that in spacetime dimension $d > 2$ the triangulations appear to need a causal, Lorentzian structure in order for the associated statistical state sums to have a continuum limit which produces macroscopic geometries with large-scale semiclassical properties. New light has been shed on our understanding of the causal structure and the notion of proper time by studying a generalized version of CDT, which maintains a well-defined notion of causality, but does not have a preferred time slicing. Already in $d = 2$, one finds an intriguing new combinatorial model, whose dynamical and global causal properties are only partially understood. I will introduce this model in some detail and describe what we have learned about it using analytical and numerical tools.

Male, **Camille** - *The distribution of traffics of large random matrices*

Free probability theory has been introduced by Voiculescu in the 80's for the study of the von Neumann algebras of the free groups. A decade later, he realized that a family of independent random matrices invariant in law by conjugation by unitary matrices are asymptotically free. This phenomenon is called asymptotic freeness and had a deep impact in operator algebra and probability. A simple particular case of Voiculescu's theorem gives an estimate, for N large, of the spectrum of an N by N Hermitian matrix $H_N = A_N + \frac{1}{\sqrt{N}} X_N$, where A_N is a given deterministic Hermitian matrix and X_N has independent Gaussian standard sub-diagonal entries.

Nevertheless, it turns out that asymptotic freeness does not hold in certain situations. For instance, in the problem of computing the asymptotic spectrum of $H_N = A_N + \frac{1}{\sqrt{N}} X_N$ as above when the entries of X_N can grow with N, one needs more information on A_N than its non commutative distribution. To answer this question, one can mimic Voiculescu's approach and state a generalized asymptotic freeness theorem for independent random matrices invariant in law by conjugation by permutation matrices (and not by unitary matrices).

Oriti, **Daniele** - *Group field theories: the combinatorics of tensor models, the quantum geometry of loop quantum gravity*

We outline the basics of group field theories, in particular their quantum geometric data. We then review recent developments in group field theory renormalisation, and also mention recent results on phase transitions and the extraction of effective cosmological dynamics from these models.

Rivasseau, **Vincent** - *Constructive tensor field theory*

I will review the construction and Borel summability of a simple quartic rank-three tensor field theory with inverse Laplacian propagator. The model requires Wick-ordering, hence a multiscale loop vertex expansion. This is work based on collaborations with T. Delepouve and R. Gurau.

Ryan, **James** - *Double scaling in tensor models*

Tensor models continue to establish themselves as a promising framework for the study of random geometry in dimensions greater than two. As the analysis of their phase structure becomes increasingly thorough, they raise more and more interesting challenges in both combinatorics and probability theory. I shall describe one such, the double scaling limit, which has been encountered and successfully overcome, raising expectations that a physically interesting regime may indeed be analytically examined within the tensor model approach.

van der Veen, **Roland** - *Symplectic properties of ideal triangulations*

Thurston's gluing equations for ideal hyperbolic triangulations have certain symplectic properties, initially discovered by Neumann and Zagier, that underlie the formulation of many classical and quantum 3-manifold invariants. It has long been suspected that these symplectic properties have an intrinsic topological interpretation. I will explain such an interpretation based on branched covers of 3-manifolds and their boundaries.

Joint work with Tudor Dimofte.