

# Abstracts

## Contents

Marc Arnaudon <i>Université of Bordeaux, France</i> .....	2
Theo Assiotis <i>University of Edinburgh, UK</i> .....	3
Guillaume Barraquand <i>CNRS, France</i> .....	4
Andrew Chee <i>Cornell University, USA</i> .....	5
Reda Chhaibi <i>Université Toulouse III, France</i> .....	6
Michael Choi <i>National University of Singapore, Singapore</i> .....	7
Kolehe Coulibaly-Pasquier <i>Université de Lorraine, France</i> .....	8
Sabine Jansen <i>Mathematisches Institut der Universität München, Germany</i> .....	9
Aldéric Joulin <i>Institut de Mathématiques de Toulouse, France</i> .....	10
Neil O’Connell <i>University College Dublin, Ireland</i> .....	11
Federico Sau <i>University of Trieste, Italy</i> .....	12
Rohan Sarkar <i>University of Connecticut, USA</i> .....	13
Mladen Savov <i>Sofia University and Bulgarian Academy of Sciences, Bulgari</i> .....	14
Dario Spano <i>Warwick University, UK</i> .....	15
Filip Stojanovic <i>Cornell University, USA</i> .....	16
Jan Swart <i>Czech Academy of Sciences, Czech Republic</i> .....	17
Matthias Winkel <i>Oxford University, UK</i> .....	18
Ali Zahra <i>Instituto Superior Técnico, Portugal</i> .....	19

Marc Arnaudon

*Université of Bordeaux, France*

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*Couplings of Brownian Motions with Set-Valued Dual Processes on  
Riemannian Manifolds*

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The purpose of this talk is to construct a Brownian motion  $(X_t)$  taking values in a Riemannian manifold  $M$ , together with a compact set-valued process  $(D_t)$  such that, at least for small enough  $(D_t)$ -stopping time  $T > 0$  and conditioned by  $D_{[0, T]}$ , the law of  $X_T$  is the normalized Lebesgue measure on  $D_T$ . This intertwining result is a generalization of Pitman's theorem. We first construct regular intertwined processes related to Stokes' theorem. Then using several limiting procedures we construct synchronous intertwined, free intertwined, mirror intertwined processes. The local times of the Brownian motion on the (morphological) skeleton or the boundary of each  $D_t$  play an important role. Several examples with moving intervals, discs, annuli, symmetric convex sets are investigated.

[Back to Contents Page →](#)

Theo Assiotis

*University of Edinburgh, UK*

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*Interacting particle systems, conditioned random walks and the Aztec diamond*

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I will talk about a general class of integrable models of interacting particles in inhomogeneous space, containing various types of inhomogeneous pushTASEPs and zero range processes, and how they are connected to determinantal point processes, random walks conditioned to never intersect and random tilings of the Aztec diamond with inhomogeneous weights.

The integrability of these models comes from a natural generalisation of Toeplitz matrices which satisfy certain intertwining relations.

[Back to Contents Page →](#)

Guillaume Barraquand  
*CNRS, France*

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[Back to Contents Page →](#)

Andrew Chee

*Cornell University, USA*

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*Canonical Lifting of Intertwining to Higher Dimensions and Applications*

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We present a theory of canonical lifting and related transformations from one-dimension to higher dimension and related spaces, e.g. the Weyl chamber, that preserve intertwining. Such constructions coincide with rich classes of intertwined complex models (1) whose connections have not previously been identified or explored and (2) have not traditionally been studied in terms of their simpler one-dimensional counterparts. These include the well studied non-intersecting Markov processes, e.g. Dyson Brownian Motion and Dyson Laguerre processes, their discrete counterparts and their associated stationary ensembles. We leverage this theory to extend results on the universality of certain scaling limits to even broader classes of models.

This work is joint with Pierre Patie (Cornell).

[Back to Contents Page →](#)

Reda Chhaibi

*Université Toulouse III, France*

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*A one-parameter family of intertwinings using curvature, and Pitman's celebrated 2M-X theorem*

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In this talk following joint work with François Chapon, from Toulouse, we will revisit Pitman's celebrated 2M-X theorem stating that twice the running maximum of Brownian motion minus its current value is Markov.

Moreover the law is the same as the norm of a 3 dimensional Brownian motion.

While Rogers and Pitman give a proof based on intertwining, this intertwining is nothing but a point in a natural one-parameter family.

We will explain how this classical result can be explained thanks to a one-parameter family of interwinings.

The interpolation parameter is interpreted as a curvature parameter, hence a strong geometric flavor.

These interpolate between flat curvature where one has a norm process and infinite curvature where one finds the 2M-X process.

If time allows, we shall explain how this was hidden in works by Bougerol and Jeulin, and that there are quantum manifestations of this intertwining

[Back to Contents Page →](#)

Michael Choi

*National University of Singapore, Singapore*

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[Back to Contents Page →](#)

Kolehe Coulibaly-Pasquier  
*Université de Lorraine, France*

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*On the separation cut-off phenomenon for Brownian motions on high dimensional rotationally symmetric compact manifolds*

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Given a family of compact, rotationally symmetric manifolds indexed by the dimension and a weighted function, we will study the cut-off phenomena for the Brownian motion on this family. Our proof is based on the construction of an intertwined process, a strong stationary time, an estimation of the moments of the covering time of the dual process, and on the phenomena of concentration of the measure. We will see a phase transition concerning the existence or not of cut-off phenomena, which depend on the shape of the weighted function.

[Back to Contents Page →](#)

Sabine Jansen

*Mathematisches Institut der Universität München, Germany*

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*Talk 1 and Talk 2: Several interacting particle systems on lattices have duality functions that are products of single-site duality functions*

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Explain how infinite-dimensional orthogonal polynomials known in non-Gaussian white noise and chaos decompositions for Lévy random fields enter the scene and how to formulate intertwining relations.

[Back to Contents Page →](#)

Aldéric Joulin

*Institut de Mathématiques de Toulouse, France*

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*On the intertwining approach for proving Poincare type functional inequalities*

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In this talk, we will introduce the notion of intertwinings between (weighted) gradient and operators and see how those identities might be used to derive Poincare type functional inequalities in various situations (non uniformly convex potentiels, perturbed product measures, log-concave measures on domains, etc.). This talk is based on a series of works in collaboration with Michel Bonnefont (Institut de Mathématiques de Bordeaux, France).

[Back to Contents Page →](#)

Neil O'Connell

*University College Dublin, Ireland*

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*Discrete Whittaker processes*

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I will discuss a Markov chain on reverse plane partitions (of a given shape) which is closely related to fundamental Whittaker functions and the Toda lattice. This process has non-trivial Markovian projections and a unique entrance law starting from the reverse plane partition with all entries equal to plus infinity. I will also outline some connections with imaginary exponential functionals of Brownian motion, a semi-discrete polymer model with purely imaginary disorder, interacting corner growth processes and discrete delta-Bose gas, and hitting probabilities for some low rank examples.

[Back to Contents Page →](#)

Federico Sau

*University of Trieste, Italy*

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*Mixing & scaling limits of the averaging process*

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The averaging process on a graph is a continuous-space Markov chain, which is commonly interpreted as an opinion dynamics, a distributed algorithm, or an interface moving through a randomized sequence of deterministic local updates. Its dynamics goes as follows. Attach i.i.d. Poisson clocks to edges, and assign real values to vertices; at the arrival times of these clocks, update the values with their average. As time runs, the averaging process converges to a flat configuration, and one major problem in the field is that of quantifying the speed of convergence to its degenerate equilibrium in terms of characteristic features of the underlying graph. In this talk, after reviewing some basic properties, intertwining relations, and recent results on mixing times for the averaging process on general graphs, we then focus on the discrete  $d$ -dimensional torus, and on some finer properties of the process in this setting. We discuss some quantitative features (e.g., limit profile, early concentration and local smoothness), and look at nonequilibrium fluctuations, a particularly interesting problem in this degenerate context lacking a non-trivial notion of local equilibrium.

[Back to Contents Page →](#)

Rohan Sarkar

*University of Connecticut, USA*

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*Intertwining of some Markov semigroups on Carnot groups of step 2*

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We consider the hypoelliptic sub-Laplacian on Carnot groups of step 2. This operator is the generator of a Markov semigroup, which is known as the horizontal heat semigroup on the Carnot group. Using some intertwining relationships, we provide a complete description of the spectrum of these operators on  $L^2(G)$ , where  $G$  denotes the Carnot group of step 2. We further consider the Ornstein-Uhlenbeck operator on  $G$  and its Lévy-type perturbations. We prove that all these perturbations are generators of some ergodic Markov semigroups on  $G$ . Moreover, under some mild conditions, all these perturbations are isospectral. Our methods rely on the Harmonic analysis on Carnot groups and some intertwining relationships.

This is a joint work with Maria Gordina (University of Connecticut).

[Back to Contents Page →](#)

Mladen Savov

*Sofia University and Bulgarian Academy of Sciences, Bulgari*

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*Intertwining of non-self-adjoint Markov semigroups*

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In this talk we will discuss question related to the intertwining of non-self-adjoint Markov semigroups. First, we are going to discuss the intertwining between minimal semigroups and how this is preserved for any Itô's recurrent extension of these semigroups. When one of the semigroups is a quasi-diffusion then we extend Krein theory of strings and offer some spectral decompositions. In this talk we will also present results concerning the spectral theory of generalized Laguerre semigroups the results on which have been the motivation for many further studies.

The results are based on joint works with P. Patie and Y. Zhao

[Back to Contents Page →](#)

Dario Spano

*Warwick University, UK*

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*Dualities and intertwining in population genetics diffusions and beyond*

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Mathematical population genetics has been an incredible culture broth for the recent developments of the modern theory of stochastic duality. Duality in genetics clarifies the intrinsic link between forward-in-time dynamics of a population's allele frequencies evolution and backward-in-time dynamics of the same population's ancestry. It has yielded a probabilistic insight into the spectral properties of both processes, and helped significantly the tractability of such processes for simulation and inference. I will review some aspects of stochastic duality - and related intertwining operators - playing a key role in the analysis of Wright-Fisher diffusion processes of population genetics and in some of their (not necessarily diffusive) generalisations, for which some open problems will be discussed.

[Back to Contents Page →](#)

Filip Stojanovic  
*Cornell University, USA*

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*An algebraic perspective for scaling limits of non-self-adjoint operators*

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[Back to Contents Page →](#)

Jan Swart

*Czech Academy of Sciences, Czech Republic*

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*A numerical search for intertwining relations*

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I will be interested in relations of the form  $PK=KQ$  where  $P, Q$ , and  $K$  are  $n$  by  $n$  matrices that are probability kernels. Such a relation is called an intertwining relation and  $K$  is called the intertwiner. To stress the different roles of  $P$  and  $Q$ , I will say that  $Q$  is intertwined on top of  $P$ . I am interested in the case that  $P$  is a given and one is looking for  $K$  and  $Q$ . In particular, the aim may be to understand the slow and fast modes of the Markov chain with transition kernel  $P$  by intertwining it with a Markov chain with a simpler transition kernel  $Q$ . Motivated by known results for birth-and-death processes, I will present a numerical method that aims to find  $K$  and  $Q$  with certain desirable properties given  $P$ . Most of this is nonrigorous, and work in progress.

[Back to Contents Page →](#)

Matthias Winkel

*Oxford University, UK*

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*Projections of the Aldous chain on binary trees: Intertwining and consistency*

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Consider the Aldous Markov chain on the space of rooted binary trees with  $n$  labelled leaves in which at each transition a uniform random leaf is deleted and reattached to a uniform random edge. Now, fix  $1 \leq k < n$  and project the leaf mass onto the subtree spanned by the first  $k$  leaves. This yields a binary tree with edge weights that we call a “decorated  $k$ -tree with total mass  $n$ ”. We introduce label swapping dynamics for the Aldous chain so that, when it runs in stationarity, the decorated  $k$ -trees evolve as Markov chains themselves, and are projectively consistent over  $k$ . The construction of projectively consistent chains is a crucial step in our construction of the Aldous diffusion on continuum trees, which is the  $n \rightarrow \infty$  continuum analog of the Aldous chain.

This is joint work with Noah Forman, Soumik Pal and Douglas Rizzolo.

[Back to Contents Page →](#)

Ali Zahra

*Instituto Superior Técnico, Portugal*

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*Single impurity in a step initial profile of the Totally Asymmetric Simple Exclusion Process*

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We study the behavior of a single impurity particle embedded at the interface separating two density regions of the Totally Asymmetric Simple Exclusion Process (TASEP). By analyzing the impurity's dynamics, characterized by two arbitrary hopping parameters  $\alpha$  and  $\beta$ , we explore its macroscopic impact on the overall system as well as its own trajectory, offering new insights into the interplay between the impurity and the TASEP environment. We systematically classify the induced hydrodynamic limit shapes based on the initial left and right densities, as well as the values of  $\alpha, \beta$ . We conceive a novel coupling tool that allows to describe the behavior of the impurity particle in an arbitrary density field, generalizing the basic coupling technique conventionally used for second-class particles. Thanks to this new tool, we extend under certain parameter conditions, Ferrari and Kipnis's known results on the asymptotic speed of a second-class particle in the rarefaction fan to the context of the impurity. We report numerical evidence of a departure from the uniform distribution of speeds under different parameter sets. As a by-product of our formalism, we provide a new simple proof of the expression of the speed of the impurity in a uniform environment, obtained by K. Mallick and B. Derrida using integrable techniques.

This is a joint work with Luigi Cantini.

[Back to Contents Page →](#)