School of Mathematics Colloquium Talks 2018-2019

27 September 2018

Dr Peter Hintz (MIT) : Stability of black holes

More than a hundred years ago, Schwarzschild first wrote down the mathematical description of a black hole; on a technical level, black holes are certain types of solutions of Einstein's equations of general relativity. While they have since become part of popular culture, many fundamental questions about them remain unanswered: for example, it is not yet known mathematically if they are stable! I will explain what that means and outline a recent proof of full nonlinear stability (obtained in joint work with A. Vasy) in the case that the cosmological constant is positive, a condition consistent with current cosmological models of the universe. The talk is intended as a non-technical introduction to the subject, with a focus on the central role played by modern microlocal and spectral theoretical techniques.

14 November 2018

Professor Vladimir Dotsenko (Trinity College Dublin) : Old and new aspects of the Poincaré-Birkhoff-Witt theorem

The Poincaré-Birkhoff-Witt theorem on universal enveloping algebras of Lie algebras is one of the fundamental results in many areas of mathematics: from differential geometry and representation theory to homological algebra and deformation quantisation. I shall give a short overview of that result and some of its proofs that emerged in about 120 years since Poincaré published a paper about it, and outline a new proof which perhaps captures its category-theoretic essence in the best way possible. The talk is partly based on a joint work with Pedro Tamaroff.

12 December 2018

Professor Barbara Niethammer (Bonn) : Smoluchowski's classical coagulation model

In 1916 Smoluchowski derived a mean-field model for mass aggregation in order to develop a mathematical theory for coagulation processes. Since Smoluchowski's groundbreaking work his model has been used in a diverse range of applications such as aerosol physics, polymerization, population dynamics, or astrophysics. After reviewing some basic properties of the model I will address the fundamental question of dynamic scaling, that is whether solutions develop a universal self-similar form for large times. This issue is only understood for some exactly solvable cases, while in the general case most questions are still completely open. I will give an overview of the main results in the past decades and explain why we believe that in general the scaling hypothesis is not true.

30 January 2019

Professor Ivar Ekeland (Paris-Dauphine) : Inverse function theorems, soft and hard

6 March 2019

Professor Kathryn Hess (Lausanne) : Topology meets neuroscience

I will present an overview of the wide variety of applications of topology to neuroscience that my group has worked on over the past few years, including classification of neuron morphologies and structural and functional connectomics and network plasticity. This work has been carried out in collaboration with the Blue Brain Project at the EPFL.

13 March 2019

Professor Thomas Mikosch (Copenhagen) : Testing independence of random elements with the distance covariance

This is joint work with Herold Dehling (Bochum), Muneya Matsui (Nagoya), Gennady Samorodnitsky (Cornell) and Laleh Tafakori (Melbourne). Distance covariance was introduced by Székely, Rizzo and Bakirov (2007) as a measure of dependence between vectors of possibly distinct dimensions. Since then it has attracted attention in various fields of statistics and applied probability. The distance covariance of two random vectors X, Y is a weighted L2 distance between the joint characteristic function of (X, Y) and the product of the characteristic functions of X and Y. It has the desirable property that it is zero if and only if X, Y are independent. This is in contrast to classical measures of dependence such as the correlation between two random variables: zero correlation corresponds to the absence of linear dependence but does not give any information about other kinds of dependencies. We consider the distance covariance for stochastic processes X, Y defined on some interval and having square integrable paths, including Lévy processes, fractional Brownian, diffusions, stable processes, and many more. Since distance covariance is defined for vectors we consider discrete approximations to X, Y. We show that sample versions of the discretized distance covariance converge to zero if and only if X, Y are independent. The sample distance covariance is a degenerate V-statistic and, therefore, has rate of convergence which is much faster than the classical $\sqrt{n}$-rates. This fact also shows nicely in simulation studies for independent X, Y in contrast to dependent X, Y.

18 June 2019

Professor Graeme Milton (University of Utah) : Exact relations for Greens functions in linear partial differential equations and boundary field equalities: a generalisation of conservation laws