Imperial College London

SIAM Student Chapter

Mathematical Physics Conference 2017

Conference Program

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G-RESEARCH

Imperial College London SIAM Student Chapter: Mathematical Physics Day 2017 Timetable

Time	Speaker	Location
9:30	Paul Geffert	Blackett 1004
10:00	Gabriele Benomio	Blackett 1004
10:30	Coffee Break	Blackett 1004
11:00	Claude Warnick (Plenary)	Blackett 1004
12:00	Lunch	Blackett 1004
13:00	Thomas Johnson	Huxley 140
13:30	Jarrod Williams	Huxley 140
14:00	Henrik J. Jensen (Plenary)	Huxley 140
15:00	Coffee Break	Huxley Common Room
15:30	Alexis Arnaudon	Huxley 140
16:00	Santiago Cabrera	Huxley 140

ABSTRACTS

Paul Geffert (Queen Mary University London)

Nonequilibrium dynamics of piecewise-smooth stochastic systems

Piecewise-smooth dynamical systems have attracted a lot of interest in the last decade. Whereas deterministic models have been studied intensely, their stochastic counterpart is still in its infancy. Systems with dry friction subjected to stochastic perturbations are prominent examples of piecewise-smooth stochastic systems. There are only a few cases known, where exact results can be obtained. We investigated a model with pure dry friction and coloured (exponentially correlated) noise. By using the unified coloured noise approximation, developed by P. Jung and P. Haenggi, an approximate expression for the stationary probability density of the velocity can be obtained, which becomes delta-peaked for an increasing correlation time of the noise, signalling a nonequilibrium localisation phenomenon, related to stick-slip transitions in systems with dry friction. These results show good agreement with the numerical simulations. To gain deeper insight to the model, we studied the equivalent two-dimensional system, computing the joint stationary density as well as the direct computation of the probability current. The latter is a clear signature of the nonequilibrium properties of the underlying dynamics. By computing the power spectral density of the velocity and increasing the correlation time of the noise, we observe a decrease of the full width at half maximum, starting around a "critical" value, which indicates the above mentioned stick-slip transition.

Gabriele Benomio (Imperial College London)

The black holes stability problem in higher dimensions

Formulated in 1915, Einstein equations describe gravitational interactions as a consequence of the curvature of spacetime. Together with its physical insight, general relativity poses a wide range of mathematical problems. In terms of the analytical study of Einstein equations, the most basic question one can ask is whether it is possible to nd explicit solutions to the equations. In fact, a number of explicit solutions have been discovered and studied so far. Because of their properties, some of these solutions are called black holes. Black hole spacetimes are the core of current research in mathematical general relativity. The two most relevant open problems in the subject are the ones related to the rigidity and stability of black holes. The talk wants to give an overview of these two problems and motivate my interest in the study of these problems in higher dimensions.

Claude Warnick (Imperial College London)

Gravitational Waves (Plenary Talk)

The recent discovery at LIGO of gravitational waves radiated by two colliding black holes is a major landmark in the study of gravitation. I will give a quick overview of the experimental results, and discuss some of the theory of gravitational waves, making connections to ideas from geometry and PDE theory.

Thomas Johnson (Imperial College London)

Linear waves on black hole spacetimes

In a landmark discovery, LIGO recently detected the gravitational waves emitted by the merger of a binary black hole system of approximately equal mass. However, binaries with very small mass ratio are amenable to perturbation theory and are of interest with the advent of LISA. Remarkably, perturbations of a Schwarzschild black hole are completely governed by two scalar waves satisfying the so called Regge-Wheeler and Zerilli equations. In this talk, we shall understand the dispersive properties of these waves via a discussion of the linear wave equation on the Schwarzschild spacetime.

Jarrod Williams (Queen Mary University London)

Approximate Killing Symmetries in General Relativity

Symmetries and conservation laws play an important role in all branches of mathematical physics. The theory of General Relativity is no exception: continuous symmetries, generated by so-called Killing vectors (KVs), have found a multitude of applications including the construction of many notable exact solutions. While the existence of an exact symmetry is highly restrictive, one might hope that there exists some weaker notion of approximate symmetry, arising as a generic feature of solutions to the Einstein field equations. In this talk I will describe recent work in which we de- fine a notion of an approximate Killing Vector, the existence of which can be proven given any (suitably smooth) asymptotically-Euclidean initial data set for the Einstein field equations. Time permitting, I will describe an application of the approximate KV to the construction of a geometric invariant which quantifies the degree of stationarity of a spacetime.

Henrik J. Jensen (Imperial College London)

Topological excitations (Plenary Talk)

The 2016 Nobel Prize in Physics was awarded to Haldane, Kosterlitz and Thouless for their work on excitations processing topological properties e.g. vortices in various two dimensional systems. We will discuss this from the view point of emergence and collective excitation and in particular consider the new type of phase transition driven by the unbinding of vortex pairs.

Alexis Arnaudon (Imperial College London)

Ideal fluids, images and noise?

In this talk, I will play with these topics and show how they are related and give interesting mathematics with applications in medical imaging. This will bring together concepts from differential geometry, Lie groups, stochastic analysis, fluid mechanics and quantum mechanics (why not?).

Santiago Cabrera (Imperial College London)

A brane realization for the Kraft-Procesi transition

I want to introduce a set of 3d N=4 quiver gauge theories whose moduli spaces are closures of nilpotent orbits. I will discuss how we understand these hyperkhler varieties by slicing them with "minimal singularities". We recently discovered that from the physical point of view, the process of slicing corresponds to performing the Higgs mechanism. This is remarkably apparent when the gauge theory is embedded in Type IIB superstring theory, where the Higgs mechanism corresponds to the motion of D3-branes along different directions. The result is that the beautiful structure that Kraft and Procesi [https://eudml.org/doc/139922] established in the closures of nilpotent orbits is bestowed upon the set of quantum field theories.

List of Participants

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