Oxbridge PDE Conference Programme

Lecture Room L3, Mathematical Institute, Oxford

18 & 19 March 2019

Monday 18 March 2019

11.00am	Registration and Coffee
11.25am	Opening Remarks
11.30am – 12.25pm	**Claude Warnick (Cambridge)** **Black Holes and Scattering Resonances** Recent experiments have, for the first time, directly measured gravitational waves created by colliding black holes. An important part of the signal from such events is the `ringdown' phase where a distorted black hole emits radiation at certain fixed (complex) frequencies called the quasinormal frequencies. To mathematically model this phenomenon, one should study geometric wave equations on a class of open geometries. I will discuss how the quasinormal frequencies can be realised as eigenvalues of a (non-standard) spectral problem, with connections to scattering resonances on asymptotically hyperbolic manifolds. If time permits I will also discuss recent work with Gajic on the asymptotically flat case.
12.30pm – 1.00pm	**Megan Griffin-Pickering (Cambridge)** **A Particle Approximation for the Kinetic Incompressible Euler Equation** We study a kinetic equation that models plasma - the Kinetic Incompressible Euler equation (KIE). This is the formal limit of the classical Vlasov-Poisson system in the `quasi-neutral' limit where the Debye length tends to zero. The Vlasov-Poisson system can itself be derived formally from a system of interacting particles, in the limit as the number of particles tends to infinity. The rigorous justification of this `mean field' limit remains a major open problem. However, in recent years, researchers have derived the Vlasov-Poisson equation rigorously from various regularised microscopic systems. In this talk, I will present a joint work with Mikaela Iacobelli, in which we give a rigorous derivation of the KIE equation from a regularised particle system, using a combined mean field and quasi-neutral limit.
1.00pm	Lunch and Group Photo (1.55pm)
2.05pm – 2.35pm	**Andreas Søjmark (Oxford)** **The Supercooled Stefan Problem: A Probabilistic Take on Blow-Ups and Global Solvability** When modelling the freezing of a supercooled liquid by means of the one-dimensional Stefan problem, it is a well-known phenomenon that the derivative of the evolving `freezing front' may explode to infinity in finite time. In this talk I will adopt a probabilist's point of view and show how this gives rise to a generalised notion of solution that naturally incorporates blow-ups. In particular, these probabilistic solutions are global in time. As the final part of my talk, I will briefly

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	outline what is known about uniqueness. This is based on joint work with Ben Hambly and Sean Ledger.
2.35pm – 3.30pm	**Sylvie Benzoni-Gavage (Lyon)** **Periodic Waves in Dispersive PDEs and Their Modulations** The talk concerns a series of work performed with Mietka, Noble, and Rodrigues on a class of Hamiltonian, dispersive PDEs that includes generalized Korteweg-de Vries equations and dispersive perturbations of the Euler equations for compressible fluids - in particular, the fluid formulation of the NonLinear Schrödinger equation. These PDEs admit families of periodic travelling wave solutions for which we want to characterize and investigate stability. Some recent analytical results will be presented for waves of either small amplitude or large wavelength..
3.35pm	Refreshments
4.00pm – 4.55pm	**Jessica Guerand (Cambridge)** **Quantization of Measures: a Gradient Flow Approach** De Giorgi method is a way to prove interior Hölder regularity of solutions of parabolic equations. While in the elliptic case the proof is completely quantitative, in the parabolic case it seems to remain a non-quantitative step: the intermediate value lemma. The purpose of this talk is to present a quantitative version of this step after introducing how it is useful to get Hölder regularity.
5.00pm – 5.55pm	**Paolo Secchi (UNIBS)** **Anisotropic Regularity of Weakly Stable Solutions to Hyperbolic Mixed Problems** We consider weakly stable hyperbolic mixed problems, in the sense that the so-called Lopatinskii conditions holds only in a weak sense. For such problems one expects a loss of derivatives for the solution from the data. We show that solutions can be estimated in suitable weighted Sobolev spaces, anisotropic in the frequency space. A similar anisotropic regularity can be shown for solutions to the evolution equation of the discontinuity front of linearized compressible vortex sheet.
7.00pm	Dinner, Rewley House, Wellington Square

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Tuesday 19 March 2019

9.00am – 9.55am	**Joachim Krieger (EPFL)** **Randomization Improved Strichartz Estimates and an Application** I will discuss joint work with. N. Burq concerning a novel class of improved Strichartz estimates for a certain data randomization, and an application to supercritical data well-posedness for certain wave equations with null-forms.
10.00am – 10.30am	**Adam Prosinski (Oxford)** **Calculus of Variations in the Anisotropic Setting** In this talk we will review some recent results concerning existence and regularity of minimisers of anisotropic variational problems. The anisotropy that we have in mind concerns different orders of derivation in different directions, thus we work with differential operators that need not be homogeneous in the usual sense. We will explain how to obtain existence and regularity statements for minimisers of such problems using the usual tools of calculus of variations (such as quasiconvexity) combined with the structural theory of anisotropic Sobolev spaces and regularity theory for linear quasielliptic equations. This talk is based on my on-going collaboration with my doctoral advisor Prof. Jan Kristensen.
10.30am	Refreshments
11.00am – 11.55am	**Aihua Wood (Oxford & AFIT)** **Through-Wall Radar Detection Analysis via Numerical Simulations** In this presentation, we present both a forward problem of generating scattered data using Maxwell's equations and, in more detail, the inverse problem of reconstructing objects hidden behind simulated walls. The reconstruction method seeks to discover the shape, size, and conductivity of the objects using a behind-walls analysis. The main feature of our reconstruction procedure is that it uses a source within the numerical field, so that the incoming field is not generated by a plane wave, and that the object is located within a set of walls that will interfere with the ability to analyze the object normally. The data used for performing this reconstruction is generated numerically, but it is also assumed that the scattered field can only be known at certain locations outside of the walled area, instead of known as a function. All of these changes violate the assumptions of the theoretical reconstructions, so a different approach is needed. We develop an appropriate adjustment to the theoretical methods presented in the literature to analyze objects in this setting. We also explore several other reconstruction schemes including machine learning and compare their numerical results.

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Midday – 12.55pm	**Jan Sbierski (Oxford)** **Uniqueness & Non-Uniqueness Results for Wave Equations** A well-known theorem of Choquet-Bruhat and Geroch states that for given smooth initial data for the Einstein equations there exists a unique maximal globally hyperbolic development. In particular, time evolution of globally hyperbolic solutions is unique. This talk investigates whether the same result holds for quasilinear wave equations defined on a fixed background. After recalling the notion of global hyperbolicity, we first present an example of a quasilinear wave equation for which unique time evolution in fact fails and contrast this with the Einstein equations. We then proceed by presenting conditions on quasilinear wave equations which ensure uniqueness. This talk is based on joint work with Harvey Reall and Felicity Eperon.
1.00pm	Lunch
2.00pm – 2.30pm	**Gabriele Benomio (Imperial)** **The Black Hole Stability Problem in Higher Dimensions: An Instability Theorem** The geometry of solutions to the higher dimensional Einstein vacuum equations presents aspects that are absent in four dimensions, one of the most remarkable being the existence of stably trapped null geodesics in the exterior of asymptotically flat black holes. I will illustrate the stable trapping phenomenon for a family of higher dimensional black holes, namely five-dimensional rotating black rings, and how this trapping structure is responsible for the slow decay of linear waves on their exterior region. The result presented is the first mathematically rigorous statement supporting the expectation that black rings are dynamically unstable to generic perturbations and allows some important remarks concerning the black hole stability problem in higher dimensions.
2.30pm – 3.25pm	**Juan-Luis Vázquez (UAM & UMC)** **Degenerate Parabolic Problems with Nonlocal Effects: From Nonlocal Porous Medium to Nonlocal Thin Film Flows** The talk presents work on the existence, regularity and typical behaviour of solutions of nonlinear parabolic equations driven by fractional operators, which introduce nonlocal effects into the classical settings. The models we discuss are related to porous medium and thin film equations. The problems in bounded domains offer new challenges.
3.30pm	Concluding Remarks

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