**OxPDE Conference 24th – 25th April 2025**

**ABSTRACTS**

**Professor Qian Wang**

***Title:*** *On global dynamics of $3$-D irrotational compressible fluids*

**Abstract:** We consider global-in-time evolution of irrotational, isentropic, compressible Euler flow in $3$-D, for a broad class of $H^4$ classical Cauchy data without assuming symmetry, prescribed on an annulus surrounded by a constant state in the exterior. By giving a sufficient condition on the initial data, we construct global exterior solutions for the broad class of data, with a rather general subclass forming rarefaction at null infinity. Our result does not require smallness on the transversal derivatives of classical data, thus applies to data with a total energy of any size.

**Ms Amelie Loher**

***Title:*** *Decay estimates for weak solutions of the Boltzmann equation*

**Abstract:** We introduce a suitable notion of weak solutions to the Boltzmann equation on bounded space domains. In case of moderately soft and hard potentials, we show that these solutions generate a pointwise decay at any polynomial rate in velocity, provided that the mass, energy and entropy of the solutions are bounded. This is joint work with Cyril Imbert.

**Professor Mahir Hadzic**

***Title:*** *On quantitative gravitational relaxation*

**Abstract:** We obtain quantitative decay rates for the linearised gravitational potential around compactly supported steady states of the Vlasov-Poisson system featuring a point mass potential at the origin. Such steady states feature stably trapped particles which present a severe obstacle to any kind of dispersion. The problem is further complicated by the presence of an infinite-dimensional kernel. To handle these issues we combine tools from dynamical systems, Hamiltonian geometry, and scattering theory. Our theorem can be viewed as a first quantitative proof of (linear) gravitational Landau damping. Joint work with Matthew Schrecker.

**Mr Christopher Wright**

***Title:*** *A Gradient Flow for Free Boundary Minimal Surfaces*

**Abstract:** In this talk, I will be discussing a new approach to the study of free boundary minimal surfaces, which is joint work with Melanie Rupflin and Michael Struwe. The idea is to study the gradient flow of a suitable non-local energy functional, which leads to a degenerate system of non-local PDEs. After motivating this approach, I will outline what is known about the behaviour of solutions of this system, in particular giving a description of the finite time singularities which may arise.

**Dr Jacub Skrzeczkowski**

***Title:*** *Nonlocal-to-local limits in physics, biology and numerical analysis*

**Abstract:** Nonlocal partial differential equations are ubiquitous in the applied sciences due to their connection with interacting particle systems. Typically, they involve nonlocal operators—such as integral operators like convolutions—that collect information about the solution across the entire space. In this talk, we discuss several application-motivated problems where it is necessary to rigorously justify the so-called nonlocal-to-local limit, that is, the limit in which the interaction radius of the nonlocal operator shrinks to zero. The examples include the numerical solution of the porous medium equation via particle methods (joint work with C. Elbar, J.A. Carrillo, and S. Fronzoni), a similar problem for the heat equation (joint work with J.A. Carrillo, A. Esposito, and J. S.-H. Wu), and the derivation of a connection between phase separation models introduced by Giacomin–Lebowitz and Cahn-Hilliard (joint work with C. Elbar).

**Dr Matthew Schrecker**

***Title:*** *Stability of Gravitational Collapse*

**Abstract:** In the Newtonian setting, a star is modelled as a spherically symmetric gas obeying the compressible Euler-Poisson system. In certain regimes, smooth initial data may give rise to blow-up solutions, corresponding to the collapse of a star under its own gravity, and such solutions have been rigorously constructed in recent years. In this talk, I will present the nonlinear stability of the simplest of these blow-up profiles, the Larson- Penston solution to the Euler-Poisson equations. This is based on joint works with Yan Guo, Mahir Hadzic, and Juhi Jang.

**Dr Rita Texeira da Costa**

***Title**: Mode stability for wave equations on black hole spacetimes*

**Abstract**: On stationary black hole spacetimes, the scalar wave equation does not admit exponentially growing-in-time modes. We discuss the classical proof of this foundational result by Whiting in 1989, and a new proof which is joint work with Casals.

**Professor Clement Mouhot**

***Title:** Gehring's lemma, old and new*

**Abstract:** Regularity theory for divergence-form elliptic and parabolic PDEs often starts with the energy estimate. Interestingly, even with rough coefficients, this energy estimate imply a higher degree of integrability of the gradient, in any dimension. This idea goes back at least to Gehring (1973), who used it proved that the differential of a quasiconformal mapping is locally integrable with a power greater than the dimension. Such gain of integrability is based on "reverse Hölder inequalities" introduced by Muckenhoupt (1972). We present an extension of this theory to the hypoelliptic equations with rough coefficients that appear in kinetic theory. This is a joint work with Jessica Guerand (University of Montpellier) and Cyril Imbert (ÉNS Paris).

**Dr Nikos Katzourakis**

***Title**: Local minimisers in higher order Calculus of Variations in L∞: existence, uniqueness and characterisation*

**Abstract:** Higher order problems are very novel in the Calculus of Variations in L∞, and exhibit a strikingly different behaviour compared to first order problems, for which there exists an established theory, pioneered by Aronsson in 1960s. In this talk I will discuss how a complete theory can be developed for second order functionals. Under appropriate conditions, “localised” minimisers can be characterised as solutions to a nonlinear system of PDEs, which is different from the corresponding Aronsson equation; the latter is only a necessary, but not a sufficient condition for minimality. I will also discuss the existence and uniqueness of localised minimisers subject to Dirichlet boundary conditions, and also their partial regularity outside a singular set of codimension one, which may be non-empty even in 1D. The talk will not assume any previous knowledge on the topic.

**Mr Yifan Jiang**

***Title:*** *Path-dependent PDEs arising from the adapted Wasserstein distance*

**Abstract:** The adapted Wasserstein distance is a generalization of the Wasserstein distance for stochastic processes. The transport map is required to be adapted with respect to the information flow generated by the underlying processes. This distance metrizes the weak adapted topology and plays a pivotal role in many problems of mathematical finance. Despite its appealing theoretical properties, few explicit computations of the adapted Wasserstein distance are known in the literature. In this talk, I will leverage tools from path-dependent PDEs and calculate the adapted Wasserstein distance for stochastic Volterra processes and fractional stochastic processes respectively.

**Dr Zoe Wyatt**

***Title:*** *A new phase transition in cosmological fluid dynamics*

**Abstract:** On flat geometries, the Euler equations (both relativistic and not) are known to admit unstable homogeneous solutions with finite-time shock formation. In cosmological settings, the spatial geometry expands at a particular rate $a(t)$ with $\dot{a}>0$. This leads to a competition between dissipation (from the expansion rate $a(t)$) and shock formation (from nonlinear advection terms). I will present some recent joint work in this direction, and a novel phase transition which arises in decelerated cosmological settings.