International PDE Conference 2022
University of Oxford
20th – 23rd July 2022

Cvent Hybrid Event w/ Timings in BST

Wednesday 20th July

09:30 – 10:25	Registration and Refreshments *St Antony's College*	*Hilda Besse Foyer*
10:30 – 10:35	Welcome Remarks **Prof. Gui-Qiang Chen** **Mathematical Institute, University of Oxford** **Prof. Endre Süli** **Mathematical Institute, University of Oxford**	*Nissan Lecture Theatre*
10:40 – 11:20	**John Ball** **Heriot-Watt University and Maxwell Institute for Mathematical Sciences, Edinburgh** **Image comparison via nonlinear elasticity** The talk will describe how models based on nonlinear elasticity can be used to compare images and parts of images. The requirement that the corresponding minimization algorithm delivers a linear map between linearly related images leads to a new condition of quasiconvexity. This is joint work with Chris Horner.	*Nissan Lecture Theatre*
11:25 – 12:05	**Pierre-Louis Lions** **Collège de France in Paris / École Polytechnique** **The Master Equation for Mean Field Games** Abstract - pending	*Remotely*
12:10 – 12:50	**Elia Bruè** **Institute for Advanced Study in Princeton** **Non-uniqueness of Leray solutions of the forced Navier-Stokes equations** In his seminal work, Leray demonstrated the existence of global weak solutions, with nonincreasing energy, to the Navier-Stokes equations in three dimensions. In this talk, we exhibit two distinct Leray solutions with zero initial velocity and identical body force. Building on a recent work of Vishik, we construct a linear unstable self-similar solution to the 3D Navier-Stokes with force. We employ the linear instability of the latter to build the second solution, which is a trajectory on the unstable manifold, in accordance with the predictions of Jia and Šverák. **Further Research:** https://annals.math.princeton.edu/2022/196-1/p03	*Nissan Lecture Theatre*
13:00 – 14:30	Lunch Break Catering will be served between 13:00 – 14:00	*Dining Hall*
14:35 – 15:15	**Eduard Feireisl** **Institute of Mathematics, Czech Academy of Sciences** **On singular limits for the Rayleigh-Benard problem** We consider the full Navier-Stokes-Fourier system in the Rayleigh-Benard setting and its singular limit in the low Mach/low Froude number. The limit problems is identified as the Oberbeck-Boussinesq system with non-local boundary conditions.	*Nissan Lecture Theatre*
15:20 – 16:00	**Charles M. Elliott** **Mathematics Institute, University of Warwick** **PDEs in Evolving Domains** Abstract - pending	*Nissan Lecture Theatre*

16:10 – 17:00	Refreshment Break	*Hilda Besse Foyer*
17:05 – 17:45	**Peter Topping** **Mathematics Institute, University of Warwick** **Hamilton's pinching conjecture** Over recent decades an extraordinary number of long-standing open problems in differential geometry and topology have been solved by the development of new technology for nonlinear partial differential equations. In this talk, intended to be accessible to specialists in PDEs of all flavours, I will discuss the topic of pinching problems where one assumes some local properties of curvature and tries to deduce global geometric and topological properties. In particular, I will explain how developments this year in Ricci flow theory have finally led to a resolution of Hamilton's pinching conjecture. Joint work with Man Chun Lee.	*Nissan Lecture Theatre*
17.50 – 18:30	**Philip Maini** **Mathematical Institute, University of Oxford** **Modelling collective cell migration in repair and disease** Collective cell movement is very common in biology, occurring in normal development, repair and disease. Here, I will consider two examples: angiogenesis – the process by which new blood vessels are formed in response to wound healing or tumour growth. By using a coarse-graining approach, we derive a partial differential equation (PDE) model for this phenomenon that is a generalisation of the classical phenomenological snail-trail model in the literature, and we show under what conditions the latter is not valid. We then consider a model for cancer cell invasion that involves a coupled system of PDEs with a degenerate cross-diffusion term, and we analyse the travelling wave behaviour of the model. **Further Research:** • S. Pillay, H.M. Byrne, P.K. Maini, Modeling angiogenesis: a discrete to continuum description, Phys. Rev. E., 95, 012410 (2017) link • M.R.A. Strobl, A.L. Krause, M.Damaghi, R. Gillies, A.R.A. Anderson, P.K. Maini, Mix and Match: phenotypic coexistence as a key facilitator of cancer invasion, Bull. Math. Biol., 82 (2020) link • C. Colson , F. Sánchez-Garduño, H.M. Byrne, P. K. Maini, T. Lorenzi, Travellingwave analysis of a model of tumour invasion with degenerate, cross-dependent diffusion, Proc. R. Soc. A 477, 20210593 (2021) supp[pdf] link	*Remotely*
18.35 – 19:25	Drinks Reception	*Buttery*
19.30 – 22:00	Dinner	*Dining Hall*

Thursday 21st July

09:30 – 10:25	Check-in and Refreshments *St Antony's College*	*Hilda Besse Foyer*
10:30 – 11:10	**Neil Trudinger** **Mathematical Sciences Institute / The Australian National University** **Convexity theory of generating functions** Generating functions are nonlinear extensions of affine functions, and more generally cost functions in optimal transportation, which were originally introduced by us as a framework to extend the PDE theory of optimal transportation to near	*Remotely*

	field geometric optics. In this talk, I will describe a geometric approach to the underlying convexity theory, which uses minimal smoothness conditions and simplifies previous arguments even in the smooth case. **Further Research:** Loeper, G., Trudinger, N.S.: On the convexity theory of generating functions, preprint, arXiv: 2109.04585 (2021)	
11:15 – 11:55	**Jan Kristensen** **Mathematical Institute, University of Oxford** Morrey's problem in classes of homogeneous integrands The question of whether rank-one convexity implies quasiconvexity is often called Morrey's problem. Sverak has shown that the answer is no in general and so a number of modifications have been proposed over the years. In this talk I will discuss some of these where positive answers have been found recently. The talk is based on joint work with Kari Astala (Helsinki), Daniel Faraco (Madrid), Andre Guerra (IAS) and Aleksis Koski (Helsinki).	*Nissan Lecture Theatre*
12:00 – 13:00	Lunch Break	*Dining Hall*
13:05 – 13:45	**Didier Bresch** **Université de Savoie (Mont Blanc) / Centre National de la Recherche Scientifique (CNRS)** **On the mean-field limit of the Vlasov-Fokker-Planck equations** In this talk, I present a recent new approach introduced in collaboration with P.-E. Jabin and J. Soler to justify the mean-field limit of stochastic systems of interacting particles, leading to the first ever derivation of the mean-field limit to the Vlasov-Poisson-Fokker-Planck system for plasmas in dimension~2 together with a partial result in dimension~3.	*Remotely*
13:50 – 14:30	**Helge Holden** **Norwegian University of Science and Technology** **Two sides of the Camassa–Holm equation: A Lipschitz metric and a noisy version** We will study two aspects of the Camassa–Holm equation, a nonlinear PDE on the line that is fully integrable and allows for solitary solutions. Solutions of the equation experience wave breaking in finite time, and loss of uniqueness. First we introduce a Lipschitz metric that compares two different conservative solutions of the equation. This is joint work with J.A. Carrillo (Oxford) and K. Grunert (NTNU). Next, we study a stochastic perturbation of a regularized version the equation. Here we show existence of a unique strong solution. This is joint work with Kenneth H. Karlsen (Oslo) and Peter H.C. Pang (NTNU)	*Nissan Lecture Theatre*
14:35 – 15:15	Refreshment Break	*Hilda Besse Foyer*
15:20 – 16:00	**Barbara Niethammer** **Hausdorff Center of Mathematics / University of Bonn** **On an obstacle problem for cell polarization** Cell polarization in response to an external chemical signal plays a crucial role in many biological processes such as the motion of cells. We discuss here a bulksurface reaction diffusion equation and derive in the regime of large rate constants a nonlocal obstacle type problem. For this limit system we prove global	*Remotely*

	stability of steady states, characterize the paramter regime for the onset of polarization and discuss regularity properties in the evolution of the free boundary.	
16:05 – 16:45	**Charles Fefferman** **Princeton University** **A PDE for Agnostic Control** The talk presents a novel flavor of control theory giving rise to a PDE about which (as far as I know) there are so far no rigorous results.	*Remotely*
16.50 – 00:00	Free Time to Explore Oxford (In person + online)	**

Friday 22nd July

09:30 – 10:25	Check-in and Refreshments *Trinity College*	*Levine Building Foyer*
10:30 – 11:10	**Alessio Figalli** **ETH Zürich** **Stable and finite Morse index solutions to semilinear elliptic equations** Stable and finite Morse index solutions to semilinear elliptic PDEs appear in several problems. It is known since the 1970's that, in dimension n > 9, there exist singularstable solutions. In this talk, I will describe a recent work with Cabré, Ros-Oton, and Serra, where we prove that stable solutions in dimension n ≤ 9 are smooth. This answers a famous open problem posed by Brezis, concerning the regularity of extremal solutions to the Gelfand problem. Also, I will discuss a recent analog result with Zhang for finite Morse index solutions.	*Remotely*
11:15 – 11:55	**Mikhail Feldman** **University of Wisconsin-Madison** **Shock reflection problem: existence and stability of global solutions** In this talk we will start with discussion of shock reflectionphenomena, and von Neumann conjectures on transition between regular and Mach reflections. Then we describe the results on existence, uniqueness, stability andgeometric properties of global solutions to shock reflection for potential flow, and discuss the techniques.The approach is to reduce the shock reflection problem to a free boundary problem for a nonlinear elliptic equation in self-similar coordinates, with ellipticity degenerate near a part of the boundary (the sonic arc). We will also discuss the open problems in the area. **Further Research:** G.-Q. Chen, M. Feldman, The Mathematics of Shock reflection-diffraction and von Neumann's conjectures, Annals of Mathematics Studies, 197. Princeton University Press, Princeton, NJ, 2018. xiv+814 pp.	*Levine Building Auditorium*
12:05 – 13:45	Lunch Break Catering will be served between 12:30 – 13:45	*Dining Hall*
13:50 – 14:30	**Kenneth H. Karlsen**	*Remotely*

	University of Oslo **A singular limit problem for stochastic conservation laws** We investigate a singular limit problem for stochastic conservation laws with discontinuous flux, perturbed by vanishing diffusion—dynamic capillarity terms. Our convergence arguments use kinetic formulations, H-measures and velocity averaging for stochastic transport equations, and a.s. representations of random variables in quasi-Polish spaces. This talk is based on joint work M. Kunzinger and D. Mitrovic.	
14:35 – 15:15	**Michael Struwe** **ETH Zürich** **Plateau flow, alias the heat flow for half-harmonic maps** Using the Millot-Sire interpretation of the half-Laplacian on $S1$ as the Dirichlet-to-Neumann operator for the Laplace equation on the ball B, we devise a classical approach to the heat flow for half-harmonic maps from $S1$ to a closed target manifold $N\subset\R^n$, recently studied by Wettstein, and for arbitrary finite-energy data we obtain a result fully analogous to the classical results for the harmonic map heat flow of surfaces and in similar generality. When N is a smoothly embedded, oriented closed curve $\Gamma\subset\R^n$ the half-harmonic map heat flow may be viewed as an alternative gradient flow for the Plateau problem of disc-type minimal surfaces.	*Levine Building Auditorium*
15:20 – 16:00	**James Glimm** **Stony Brook University** **Entropy Admissibility and Turbulent Structure for Fluids** We show that a class of solutions defined by Lebesgue measure on phase space maximizes the rate of entropy production. Entropy is defined as the log volume of a surface of constant energy. Energy itself is dependent on details of the physics model, and for single fluid incompressible flow is the energy of velocity fluctuations and of vorticity fluctuations. Purturbation theory suggested by quantum field theory is defined. It is believed to be asymptotic, not convergent. We show that resummation of the series converges. Infinite moments of turbulence require renormalization in this series, which is accomplished through use of Sobolev norms of negative index. Insight into the nature of turbulence is derived from this series in the form of surfaces in 3-space (vortex spheres, tori of various genus, knotted and twised), describes the states of fully developed turbulent flow.	*Levine Building Auditorium*
16:05 – 16:45	Refreshment Break	*Levine Building Foyer*
16:50 – 17:30	**Irene Fonseca** **Centre for Nonlinear Analysis / Carnegie Mellon University** **Phase Separation in Heterogeneous Media** Modern technologies and biological systems, such as, temperature-responsive polymers and lipid rafts, respectively, take advantage of engineered inclusions, or natural heterogeneities of the medium, to obtain novel composite materials with specific physical properties. To model such situations by using a variational approach based on the gradient theory, the potential and the wells have to depend on the spatial position, even in a discontinuous way, and different regimes should be considered. In the case where the scale of the small heterogeneities is of the same order of the scale governing the phase transition, the interaction between homogenization and the phase transitions process leads to an anisotropic interfacial energy. In the case where the heterogeneities of the material are of a larger scale than that of the diffuse interface between different phases, it is noted	*Remotely*

	that there is no macroscopic phase separation and that thermal fluctuations play a role in the formation of nanodomains. In addition, a characterization of the large-scale limiting behavior of viscosity solutions to non-degenerate and periodic Eikonal equations in half-spaces is given. This is joint work with Riccardo Cristoferi (Radboud University, The Netherlands), Likhit Ganedi (CMU, USA), Adrian Hagerty (USA), Cristina Popovici (USA), Rustum Choksi (McGill, Canada), Jessica Lin (McGill, Canada), and Raghavendra Venkatraman (NYU, USA).	
17:35 – 18:15	**Robert V. Kohn** **Courant Institute of Mathematical Sciences / New York University** **Mathematical analysis of some devices made using epsilon-near-zero materials.** A body of literature has emerged concerning the design of devices made using "epsilon-near-zero" (ENZ) materials. The underlying mathematics is linear -- it uses the time-harmonic Maxwell's equations (epsilon is the dielectric permittivity). In a transverse-magnetic setting, the governing PDE reduces to a divergence-form Helmholtz equation, - div(a(x) grad u) = k^2 u, in which the coefficient a(x) is 1/epsilon. One sees quickly what is special about ENZ materials: if epsilon is nearly 0 in some region, then a(x) is nearly infinite, and the function u is nearly constant. To understand the robustness of ENZ devices, it is important to understand the leading-order corrections to the ENZ limit. This leads to interesting questions of both analysis and optimal design. This is joint work with Raghavendra Venkatraman.	*Remotely*
18.30 – 19:10	Drinks Reception with Canapés *Ashmolean Museum Restaurant* - arrival via St Giles entrance (view street location)	*Rooftop Terrace*
19:15 – 20:00	Private Curator Led Tour of Pre-Raphaelites: Drawings and Watercolours	*Museum*
20:15 – 22:00	Dinner 10:00 PM Carriages	Restaurant

Saturday 23rd July

09:30 – 10:25	Check-in and Refreshments *Trinity College*	*Levine Building Foyer*
10:30 – 11:10	**Denis Serre** **Ecole Normale Supérieure de Lyon** **Compensated Integrability and Conservation Laws** Compensated Integrability, a tool from Functional Analysis, applies to positive semi-definite tensors whose row-wise Divergence is a finite measure. Div-free tensors occur naturally in various models of Mathematical Physics, as a consequence of N{\oe}ther's Theorem. Somehow, Compensated Integrability is dual to Brenier's existence result for the "second BVP" for the Monge--Ampère equation. It extends in a non-trivial manner the Gagliardo--Nirenberg--Sobolev Inequality, or the Isoperimetric Inequality. In the periodic situation, it expresses the Div-quasiconcavity of $A\mapsto(\det A)^{\frac1{n-1}}$ a non-concave function over ${\bf Sym}_n^+$), leading to a weak upper-semicontinuity result.	*Levine Building Auditorium*

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	When it applies, C.I. yields dispersive (Strichartz-like) estimates. In Gas Dynamics, the internal energy cannot concentrate on zero-measure subsets. Other applications concern kinetic equations (Boltzman), mean-field models (Vlasov), molecular dynamics. The corresponding tensor is positive semi-definite whenever the particles interact pairwise according to a radial, repulsive force. In hard spheres dynamics, the Div-free tensor is supported by a graph, and a special form of C.I. is required. Another relevant topic is that of multi-dimensional conservation laws, where C.I. allows us to extend Kru\v{z}kov's theory to L^p-data when p is finite, under a non-degeneracy assumption (collaboration with L. Silvestre).	
11:15 – 11:55	**Lawrence C. Evans** **University of California, Berkeley** **Compactness and the curvature of 3-webs** Abstract - pending	*Levine Building Auditorium*
12:00 – 12:25	Concluding Remarks	*Levine Building Auditorium*
12:30 – 14:00	Lunch Break	*Dining Hall*
14:00	Close	**

Organisers Prof. Gui-Qiang G. Chen (University of Oxford)
Prof. Endre Süli (University of Oxford)

This conference is hybrid with seminars taking place live in-person and virtually. Access to the event including registration, agenda, presentations, and more are managed via the Cvent Registration site and Attendee Hub which will be made available to participants who have registered in advance.

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Conference website with details on speakers, presentation titles and abstracts HERE

Cvent Attendee Hub to view the sessions, join the discussions, schedule meeting appointments together with viewing the programme and your personal schedule HERE