On MEMS type equations: local and non-local problems

Feng Zhou
East China Normal University, Peoples Republic of China

In this talk, we will discuss some semilinear elliptic and parabolic equations with negative exponent arising from MEMS, and show how the permittivity profile and the shape of membranes effects on the pull-in voltage (the critical value of the applied voltage) and the structure of solutions set. We study qualitative properties of minimal solutions and in particular, we give a complete analysis for the stability of the minimal solutions. We discuss also a nonlocal MEMS type equation with variable dielectric permittivity. This talk is based on joint works with H.Y. Chen, Y.J. Guo, Y. Wang and Y.Y. Zhang.|

Short Bio: Feng Zhou is a Professor of Mathematics at East China Normal University. He has received his Ph.D. in mathematics at the University of Paris VI (Sorbonne). His current research interests include partial differential equations and calculus of variations, for instances, on the qualitative properties of solutions to some elliptic equations arising from geometry and physics. In particular he is interested by the properties of solution related to the geometry and/or topology of domain, the multiplicity and regularity and blow up phenomenon.

Quantitative properties of co-rotational Beris-Edward system in critical spaces $L^3 \left(\mathbb{R}^3 \right)$

Xianpeng Hu
The Hong Kong Polytechnic University, Hong Kong S.A.R. of China

We will discuss the co-rotational Beris-Edwards system, which models incompressible liquid crystal flows with Laudau-De Gennes bulk potential. We establish the quantitative blow-up rates for critically bounded solutions of the co-rotational Beris-Edwards system. We applied the cancellation property to deal with the loss of regularity for Q tensors. Moreover, with the help of linearization of Q tensors and the partial regularity for perturbed co-rotational Beris-Edwards system, we establish a refined quantitative Carleman estimate based on the vorticity-Hessian formulation to overcome the bulk potential.

Short Bio: Xianpeng Hu is a Professor at Department of Applied Mathematics at The Hong Kong Polytechnic University. He is working on Partial Differential Equations from continuum mechanics. His research had been supported by National Science Fund of USA, Research Grant Council of Hong Kong.

Phase transitions in liquid crystals

Yong Yu
The Chinese University of Hong Kong, Hong Kong S.A.R. of China

The dynamical phase transitions will be discussed. Attentions will be paid on the so-called P-HAN transition, which is the transition from the unidirectional phase to the hybrid aligned nematic phase.

The thickness threshold is explicitly found, below which the unidirectional phase is stable. Above the thickness threshold, the liquid crystals prefer a new equilibrium state. The results rigorously justify the P-HAN transition observed in experiments and numerical studies.

Short Bio: Professor Yong Yu obtained his B.Sc. from Fudan University in 2001. Since 2001 to 2004, he studied with Prof. Ta-Tsien Li for the M.Sc.. Thereafter, he went to NYU and got his Ph.D. degree under the supervision of Prof. Fanghua Lin. From 2009 to 2012, he served as visiting assistant professor at University of Iowa. Since 2012, he has been working in The Chinese University of Hong Kong. Main interests of Prof. Yu are in the geometric flow of liquid crystals. In particular, he studied formation of singularities, instability of liquid crystal flows, and phase transition below/beyond some critical threshold.

Periodic solutions of Newtonian N-body problems

Shiqing Zhang
Sichuan University, Peoples Republic of China

The N-body problem with Newtonian potential is a classical problem, which is related with the motions of the N bodies under the universal gravitational forces of all the bodies. Because the potential may have singularities, and the Lagrangian action can be finite on collision generalized solutions for Newtonian-type weak force potentials, it is difficult to find classical non-collision periodic solutions by using variational methods. In this talk, I will talk about how to use variational methods to find classical non-collision periodic solutions.

Short Bio: Zhang Shiqing obtained his Ph.D. from the Chern Institute of Nankai University in 1991. He was awarded eight grants from National Science Foundation of China and published a book in Springer, and more than 50 papers on SIAM J, ARMA, DCDS-A, Nonlinearity, JDE, Cel. Mechanics, Science in China etc.

Rigidity for steady incompressible Euler system and its applications

Chunjing Xie
Shanghai Jiao Tong University, Peoples Republic of China

When the steady flows are away from stagnation, the associated Euler equations can be locally reduced to a semi-linear equation. On the other hand, stagnation of flows is not only an interesting phenomenon in fluid mechanics, but also plays a significant role in understanding many important properties of fluid equations. It also induces many challenging problems in analysis. First, we discuss the scenario when the Euler equations can be reduced to a single semi-linear equation in terms of stream function. Second, we give a classification of incompressible Euler flows via the set of flow angles. Finally, the applications of these classifications for the analysis on vanishing viscosity limit of fluid will be addressed.

Short Bio: Chunjing Xie is a Professor at Shanghai Jiao Tong University. He received his B.Sc. in Wuhan University, and Ph.D. degree in The Chinese University of Hong Kong. Before he joined Shanghai Jiao Tong University, he was a postdoctoral fellow at University of Michigan. His main research interests are the analysis on qualitative properties and well-posedness of steady flows in

various physical domains, in particular, the rigidity of steady solutions of Navier-Stokes system and Euler system, the well-posedness of Euler system in channels, stability of steady solutions of the Euler-Poisson system, etc. He has published more than 30 papers in Adv. Math., ARMA, CMP, etc.

Normalized solutions for mass supercritical nonlinear Schrödinger equations in bounded and exterior domains

Xiaojun Chang
Northeast Normal University, Peoples Republic of China

We present recent existence results for normalized solutions of mass-supercritical non-linear Schrödinger equations (NLSE) in bounded and exterior domains. Whereas the whole-space case has been intensively studied via Nehari-Pohozaev identities, these tools collapse on non-convex bounded sets or unbounded exterior regions. In this talk, we present some existence results for mass-supercritical NLSE in general bounded domains under both Dirichlet and Neumann boundary conditions, as well as in exterior domains. Our approach employs minimax arguments that incorporates Morse index information for constrained functionals, combined with a blow-up analysis of approximate solutions with bounded Morse index and prescribed mass.

Short Bio: Xiaojun Chang is a Professor at the School of Mathematics and Statistics, Northeast Normal University. His research focuses on variational methods with applications to ordinary and partial differential equations. He has published over 40 papers in peer-reviewed journals, including AIHPC, TAMS, JDE, and Nonlinearity.

On bubbling phenomenon of Brezis-Nirenberg problems: open questions and new results in low dimensions

Yuanze Wu
Yunnan Normal University, Peoples Republic of China

In this talk, I shall discuss the bubbling phenomenon of the famous Brezis-Nirenberg problem in general bounded domains. I will first recall the history of the studies on the bubbling phenomenon of the Brezis-Nirenberg problem and report our new results in this direction, including the construction of new bubbling phenomenon and the classification of the one-bubble case under an assumption on dimensions. Finally, I will also list some open questions on the Brezis-Nirenberg problem. This talk is based on two recent works. One is joint with Fengliu Li, Giusi Vaira and Juncheng Wei and another one is joint with Rui He and Xiangqing Liu.

Short Bio: Yuanze Wu, who serves as a Full Professor of the school of mathematics of Yunnan Normal University and executive director of Yunnan Research Center of Modern Analysis and Partial Differential Equations, works in non-linear analysis and its applications in elliptic equations. He has published over 30 papers in many international journals including J. Math. Pures Appl., Math. Ann., J. Funct. Anal., Math. Z., J. London Math. Soc. and so on.

Analysis and control of a nonisothermal Cahn-Hilliard system with source term

Pierluigi Colli
University of Pavia, Italy

The talk is concerned with a temperature-dependent phase transition system of Cahn-Hilliard type. The related model extends the classical nonisothermal phase separation framework proposed by Caginalp by coupling a Cahn-Hilliard equation for the order parameter - with an additional source term - to the universal balance law of internal energy. In contrast with the standard Fourier heat conduction law, the heat flux follows the Green-Naghdi theory, which accounts for possible thermal memory effects in the system's evolution. This formulation gives rise to a second-order-in-time equation for the thermal displacement (or freezing index), defined as the time primitive of the temperature. A distinctive feature of the model is the presence of the source term in the equation for the order parameter, which breaks mass conservation and introduces some analytical challenges. We present mathematical results under general assumptions on the source term and on the double-well potential governing the phase separation process.

Short Bio: Pierluigi Colli is a Full Professor of Mathematical Analysis since 1994. He has authored more than 200 research papers on non-linear evolution problems arising in thermodynamics, mathematical physics, and biomedicine, with a particular focus on existence and uniqueness results, regularity theory, optimal control, and the asymptotic behavior of solutions to partial differential equations. He currently serves on the editorial boards of two international scientific journals.

A viscoelastic Cahn-Hilliard phase-field model at large strains

Elisabetta Rocca
University of Pavia, Italy

The talk is related to recent joint works with Abramo Agosti, Pierluigi Colli, and Harald Garcke, where we propose a new Cahn-Hilliard phase-field model coupled to incompressible viscoelasticity at large strains, obtained from a diffuse interface mixture model and formulated in the Eulerian configuration. A new kind of diffusive regularisation, of Allen-Cahn type, is introduced in the transport equation for the deformation gradient, together with a regularising interface term depending on the gradient of the deformation gradient in the free energy density of the system. The designed regularisation preserves the dissipative structure of the equations. We study the global existence of a weak solution for the model.

Short Bio: Elisabetta Rocca is a Full Professor in Mathematical Analysis at the University of Pavia since November 2018. After obtaining her Ph.D., she spent ten years at the University of Milan and two years at WIAS in Berlin where she coordinated a research group within the ERC Stg-Grant she was awarded in 2011. She is author of more than 100 papers on the analysis of PDEs related to applications in engineering, industry and bio-medicine.

On overview of the "Cahn-Hilliard-Keller-Segel" model: existence, regularity and long-time behavior

Giulio Schimperna
University of Pavia, Italy

In this talk we will discuss the state of the art of the mathematical research regarding the so-called "Cahn-Hilliard-Keller-Segel" model. This is a recently proposed model which couples the Cahn-Hilliard system for phase separation with a further equation describing the evolution of an additional variable σ. The main application of the model refers to tumor growth processes, in which the phase variable φ represents the local proportion of active cancer cells, whereas σ denotes the concentration of a chemical substance (for instance a nutrient or a drug) affecting the evolution of the tumor. In this setting, the equation for σ may be characterized by a quadratic cross-diffusion term similar to that occurring in the Keller-Segel model for chemotaxis. In the talk we will discuss about existence, uniqueness and regularity of several classes of solutions ("weak", "strong" and "entropic") under various assumptions on the mass and nutrient source terms occurring in the system; in a specific situation we will also analyse the long-time behavior of solutions under the perspective of infinite-dimensional dynamical systems.

Short Bio: Giulio Schimperna earned his degree in Mathematics from the University of Pavia in January 1995 and his Ph.D. in Mathematics from the University of Milan in January 2000. Since 2018, he has been a Full Professor of Mathematical Analysis at the University of Pavia. Professor Schimperna has authored approximately 100 research papers published in leading international scientific journals. His scientific interests are mainly devoted to evolutionary partial differential equations of nonlinear type and, more specifically, to problems related to mathematical models in phase transitions, damaging, thermomechanics, viscoelasticity and fluid dynamics.

How do different layers couple in a multi-layer porous media system for convection?

Xiaoming Wang
Eastern Intitute of Technology, Peoples Republic of China

Layered porous media, characterised by abrupt material transitions, are common in geophysics and engineering. While the Darcy-Boussinesq equations describe such systems as non-linear transmission problems, the correct interfacial conditions are not always clear. We address this by considering a diffuse-interface model, where properties vary smoothly across a thin transition layer. We prove that as this layer vanishes, solutions of the diffuse model converge to those of the sharp-interface problem on finite time intervals. The analysis reveals a velocity boundary layer and hinges on delicate estimates for problems with nearly discontinuous coefficients. Furthermore, we establish the existence of global attractors for both models and prove their convergence in the sharp-interface limit, leveraging a novel interpolation estimate. This provides a rigorous justification for the sharp-interface approximation. I will also briefly present related numerical methods if time allows. This is joint work with Hongjie Dong (Brown University) and Kaijian Sha (EIT).

Short Bio: Dr. Xiaoming Wang received his B.Sc. and M.Sc. degrees from Fudan University. He earned his Ph.D. from Indiana University Bloomington and subsequently served as a Courant Instructor at NYU. His primary research interests lie in applied analysis, with a particular emphasis

on fluid-related problems. Dr. Wang has held tenured positions at several institutions, including Fudan University, the Southern University of Science and Technology, Florida State University, and Iowa State University. He joined the Eastern Institute of Technology in 2024 as a Founding Chair Professor.

Multi-vortices and lower bounds for the attractors dimension for the 2D Navier-Stokes equations

Sergey Zelik
Zhejiang Normal University, Peoples Republic of China

I will present a new approach to lower bounds for the attractor dimensions kn hydrodynamics, which is not based on Kolmogorov flows. Instead, it requires the existence of a single exponentially unstable vortex for the corresponding problem on the whole plane. Taking a sum of such vertices, which are well-separated in space, it is possible to construct a multi-vortex which replaces Kolmogorov flows. In particular, this method applicable to Navier-Stokes equations in bounded domains and allows to obtain the lower bounds, which were previously known for the case of periodic boundary conditions only.

Short Bio: Sergey Zelik belongs to Russian mathematical school or, more precisely, to the school of Mark Vishik. He defended his Ph.D. in 1998 and his habitation (doctor of science) in 2004. His major areas of research are Analysis of PDEs and Dynamical Systems, he published more than 150 research papers (many of them in leading mathematical journals, such as CPAM, Mem. of AMS, Comm. Math. Phys, JMPA, etc.) cited about 4000 times in approximately 2000 papers (according g to MathSciNet database).

The Cahn-Hilliard equation with a nonlinear source term

Alain Miranville
University of Le Havre, France

Our aim in this talk is to discuss the well-posedness and regularity of solutions to Cahn-Hilliard type equations with logarithmic potentials and non-linear source terms. Such equations have applications in phase separation, biology, tumor growth, image processing, ...

Short Bio: Alain Miranville is a Distinguished Professor at Le Havre Normandie University. His main research themes are parabolic PDEs with applications to materials science, biology and medicine. He is editor in chief of several journals, including Asymptotic Analysis, DCDS-S and Electronic Research Archives.

Radon measure-valued solutions and mathematics of hypersonic flows

Hairong Yuan

East China Normal University, Peoples Republic of China

In this talk I will review the progress we made on a mathematical theory of inviscid hypersonic flows based upon the framework of Radon measure-valued solutions of the compressible Euler equations. It is shown that the hypersonic Mach number independence principle, the Newtonian theory of infinite-thin shock layer, and the Newtonian-Busemann pressure law, as well as the hypersonic similarity law, can all be verified rigorously in this new framework, which put a foundation for future theoretical studies and applications.

Short Bio: Prof. Hairong Yuan received his Ph.D. from Fudan University in 2006 and has been a faculty member at East China Normal University since then. He specialised in the theory of hyperbolic conservation laws and weak solutions of the compressible Euler equations. His research includes systematic studies of stationary transonic shocks in nozzles and of Radon measure-valued solutions, with applications to hypersonic aerodynamics.

Asymptotic analysis of fast diffusion on bounded domains

Goro Akagi

Tohoku University, Japan

In this talk, we overview recent developments for quantitative analysis of asymptotic behavior of energy solutions to the Cauchy-Dirichlet problem for fast diffusion equations posed in bounded domains. It is well known that every energy solution vanishes in finite time and a suitably rescaled solution converges to an asymptotic profile, which is a nontrivial solution for a semilinear elliptic equation. Bonforte and Figalli (CPAM, 2021) first determined an exponential rate of convergence to nondegenerate positive asymptotic profiles for nonnegative rescaled solutions in a weighted L^2 norm for smooth (at least C^2) bounded domains by developing the so-called nonlinear entropy method. On the other hand, the speaker (ARMA, 2023) developed an energy method along with a quantitative gradient inequality and also proved the same exponential convergence in the Sobolev norm for bounded $C^{1,1}$ domains. The optimality of the exponential rate was conjectured in view of some formal linearized analysis; however, it was not proved due to some difficulty arising from nontrivial stability nature of asymptotic profiles in the fast diffusion setting. Furthermore, the nondegeneracy of asymptotic profiles was indispensable in these works. In this talk, these results are extended to possibly sign-changing (nondegenerate) asymptotic profiles as well as general bounded domains by improving the energy method as well as the quantitative gradient inequality. Moreover, the optimality of the exponential rate is also proved. Furthermore, such a quantitative analysis is also extended to degenerate asymptotic profiles. This talk is based on recent joint works with Yasunori Maekawa (Kyoto University) and Norihisa Ikoma (Keio University).

Short Bio: Goro Akagi received his Ph.D. from Waseda University, Tokyo, in 2004. After appointments at Shibaura Institute of Technology and Kobe University, he has been a Full Professor at the Mathematical Institute, Tohoku University since 2016. From 2015 to 2018, he spent approximately one and a half years at the Technical University of Munich as a research fellow of the Alexander von Humboldt Foundation. His research interests lie in the theory of evolution equations and applications to PDEs such as nonlinear diffusion equations and Allen-Cahn/Cahn-Hilliard equations.

On the essential numerical ranges and essential spectra of singular Hamiltonian systems

Huaqing Sun

Jiangsu Normal University, Peoples Republic of China

This talk is concerned with essential numerical ranges and essential spectra of Hamiltonian systems with one singular endpoint. For semi-bounded systems, the characterisation of each element of the essential numerical range in terms of certain singular sequences is given, the concept of form perturbation small at the singular endpoint is introduced, and the stability of the essential numerical range is obtained under this perturbation, which shows the stability of the infimum or supremum of the essential spectrum. Some sufficient conditions for the invariance of the essential numerical range are given in terms of coefficients of Hamiltonian systems.

Short Bio: Dr. Huaqing Sun is a Distinguished Professor and Doctoral Supervisor at Jiangsu Normal University. She previously served as Lecturer, Associate Professor, Professor, and Doctoral Supervisor at Shandong University (2007-2023), and later as Professor and Doctoral Supervisor at Northeastern University (2023-2025). During her tenure at Northeastern University, she also held the positions of Director of the Mathematics and Interdisciplinary Science Research Center and Director of the Mathematics Interdisciplinary and Applied Society of the Liaoning Mathematical Society. Dr. Sun has been entitled as a Leading Talent in Shenyang City, Liaoning Province. Her research focuses on the spectral theory of differential and difference operators within the field of fundamental mathematics. She has extensive publishing research results in journals including Journal of Functional Analysis, Journal of Differential Equations, Proceedings of the Royal Society of Edinburgh Section A, Applied Mathematics and Computation, and Computers & Mathematics with Applications, etc.

Compressible viscoelastic flows with zero shear viscosity and general pressure law

Ting Zhang

Zhejiang University, Peoples Republic of China

In this talk, we study the three dimensional compressible viscoelastic flows with zero shear viscosity, and a general class of pressure laws. We do not need the monotonically increasing pressure law with the help of the elasticity coefficient θ of the fluid, only need the condition $P'(1) + \theta > 0$. We shall reformulate the systems with the new perturbation variables ($\rho - 1, u, F - \frac{1}{\rho}I$) and ($\rho - 1, u, F - I$) to deal with the compressible and incompressible parts, separately. For the compressible parts, we shall use the vector fields methods to derive the weighted energy decay. For the incompressible parts, a local energy decay will be applied to derive the weighted estimates. To overcome the difficulty of the lack of dissipation for the incompressible parts, we shall introduce "good unknowns", and use the implicit structure of the nonlinearities. With the help of vector fields, we derive the weighted L^2 energy to prove global stability around a constant equilibrium. Based on the work with Xianpeng Hu and Song Meng.

Short Bio: Ting Zhang is a Professor at the School of Mathematical Sciences, Zhejiang University. His research focuses on harmonic analysis, PDEs, and Mathematical Theory in Fluid Mechanics,

with particular emphasis on the mathematical theory of the Navier-Stokes equations and related hydrodynamic systems.

On steady transonic shocks in a finite nozzle with prescribed pressure at the exit

Beixiang Fang
Shanghai Jiao Tong University, Peoples Republic of China

In this talk, we are concerned with the inviscid 2D steady Euler flow pattern with a single shock front in a finite nozzle, which enters the nozzle with a supersonic state and leave with a subsonic one. We are going to report our recent results on well-posedness of the transonic shock soluitons with the prescribed receiver pressure at the exit of the nozzle, as proposed by R . Courant and K.O. Friedrichs in their monograph "Supersonic Flow and Shock Waves".

Short Bio: Beixiang Fang is a Professor at the School of Mathematical Sciences, Shanghai Jiao Tong University. He obtained his Ph.D. from Fudan University. Professor Fang's research focuses on the mathematical theory for weak solutions of systems of high-dimensional conservation laws. A series of meaningful results have been published in Comm. Pure Appl. Math., Adv. Math., Arch. Rat. Mech. Anal., SIAM J. Math. Anal., J. Diff. Equ. and other journals.

On non-isothermal flows of dilute incompressible polymeric fluids

Josef Málek
Charles University Prague, Czechia

This talk presents the first result on the long-time existence of weak (variational) solutions to the incompressible Navier-Stokes-Fourier-Fokker-Planck equations in three dimensions. This system describes non-isothermal flows of dilute polymer chains (dumbbells) in a Newtonian solvent. A secondary objective is to elucidate the connection between the development of the mathematical theory and the formulation of constitutive equations for such fluids within an elegant thermodynamic framework. In the first part of the talk, we show that thermodynamically consistent models for non-isothermal flows of such fluids can be derived in a very elementary manner. Our approach is based on identifying the energy storage mechanisms and entropy production mechanisms in the fluid of interest, which in turn leads to explicit formulae for the Cauchy stress tensor and for all the fluxes involved. Having identified these mechanisms, we first derive the governing system of nonlinear partial differential equations coupling the unsteady incompressible temperature-dependent Navier-Stokes equations with a temperature-dependent generalisation of the classical Fokker-Plank equation and a thermal equation.

Short Bio: Josef Málek is a Professor at the Faculty of Mathematics and Physics, Charles University, director of the Nečas Center for Mathematical Modeling, and the head of the Department of Mathematical Modeling. Throughout his career, he has held visiting research and academic positions at several institutions, including the University of Bonn and Texas A & M University. Professor Málek made seminal contributions to the theoretical analysis of nonlinear partial differential equations, in particular to those describing flows of non-Newtonian fluids and deformations of nonlinear solid mechanics. Professor Málek is the editor-in-chief of the Nečas Center book series, published by Birkhäuser, since 2018. He also serves as an editor-in-chief

of the International Journal of Engineering Science, and is a member of the editorial boards of Applications in Engineering Science, Applications of Mathematics, and Nonlinear Analysis Real World Applications. Since 2021, he has served as vice-chair of the Committee for Application and Interdisciplinary Relations of the European Mathematical Society (EMS). He is co-founder of EMS topical activity group Mixtures (2023).

On data assimilation methods for fluid flows driven by temperature gradient

Eduard Feireisl
Czech Academy of Sciences, Czechia

We consider the Navier-Stokes-Fourier system describing the evolution of a compressible temperature driven rotating fluid - a model arising in meteorology. We show convergence of a continuous data assimilation (CDA) method in the regime of low Mach/high Rossby numbers. This is the first result on convergence of CDA method for a system that is not (known to be) well posed.

Short Bio: Eduard Feireisl is Senior Research worker at the Institute of Mathematics of the Czech Academy of Sciences and Professor of the Charles University in Prague. Research interests include partial differential equations with applications to fluid mechanics, numerical analysis, and stochastic equations.

On a diffuse-interface model for incompressible two-phase flows with chemotaxis and mass transport

Hao Wu
Fudan University, Peoples Republic of China

We consider a diffuse interface model for viscous incompressible two-phase flows where the effects of chemotaxis and mass transport are taken into account. The evolution system couples the Navier-Stokes equations for the volume averaged fluid velocity, a convective Cahn-Hilliard equation for the phase-field variable, and an advection-diffusion equation for the density of the chemical substance. This hydrodynamic system is thermodynamically consistent and it generalises the Abels-Garcke-Gruen model for incompressible two-phase flows with unmatched densities. For the initial-boundary value problem in two dimensions, we report some recent progresses on the existence of global weak solutions and their propagation of regularity.

Short Bio: Wu Hao is a Professor at the School of Mathematical Sciences, Fudan University, where he began his academic career in 2009 and was promoted to Full Professor in 2014. He received his B.Sc. in 2003 and his Doctorate in 2007 from Fudan University under the supervision of Professor Songmu Zheng. His research focuses on the well-posedness of nonlinear evolution equations and the long-time behavior of their global solutions, with contributions in fields such as phase-field models and hydrodynamic systems for liquid crystal flows.

Analysis of liquid crystal flows

Matthias Hieber
Technische Universität Darmstadt, Germany

In this talk we discuss two models describing the dynamics of nematic liquid crystal flows, the Q-tensor model and the Ericksen-Leslie model. We establish local and small data global wellposedness results for these mixed-order systems subject to general stress tensors and anisotropic elasticity. This is joint work with A. Hussein, M. Wrona as well as J. Li and M. Wilke.

Short Bio: Matthias Hieber earned his Ph.D. in 1989 in the area of evolution equations from Tubingen University in Germany. Upon his move to the University of Zürich in Switzerland he began investigating problems in mathematical fluid dynamics. After being elected as Full Profesor and head of the Applied Analysis Group in Darmstadt, Germany, he was member of the center of exellence on Smart Interfaces in Darmstadt from 2006-2013 and acted as the spokesperson of an International Research Group on Fluid Dynamics between Darmstadt and Tokyo from 2009-2018. In 2020 he was elected vice director of the Mathematical Research Institute at Oberwolfach (MFO); in 2022 he held the Jean Morlet Chair of CIRM at Luminy, France. Since 2023 he serves as the spokesperson of a Research Unit on Geophysical Flows, also funded by the German National Science foundation (DFG). He has written several books, authored and coauthored more than 120 research articles in mathematics, serves as managing editor or member of the editorial board of several research journals in mathematics and was hosting several Humboldt Fellows.

Quantitative homogenisation in periodic high contrast environments

Wenjia Jing
Tsinghua University, Peoples Republic of China

We consider elliptic equations with periodic high contrast coefficients and study the asymptotic analysis when the periodicity is sent to zero and/or the contrast parameters are sent to extreme values. Those coefficients model small inclusions that have very different physical properties compared to the surrounding environment. Homogenisation captures the macroscopic effects of those inclusions. We report some quantitative results such as the convergence rates of the homogenisation (with proper correctors), uniform regularity for the solutions of the heterogeneous equations, and so on. The talk is based on several joint works with H. Ammari, Y. Du and X. Fu.

Short Bio: Dr. Jing Wenjia is an Associate Professor at Yau Mathematical Sciences Center, Tsinghua University. Prior to joining Tsinghua University, Professor Jing has held various positions, including L.E. Dickson Instructor at the University of Chicago and Postdoctoral Researcher at Ecole Normale Supérieure. He obtained his Ph.D. in Applied Mathematics from Columbia University in 2011, under the supervision of Guillaume Bal, following a B.Sc. in Theoretical and Applied Mechanics from Peking University. Professor Jing's research focuses on Analysis and Partial Differential Equations, Stochastic Homogenisation and Quantitative Estimates, Waves Propagation in Random Media, and other Applied Analysis.

Global controllability of fluid flows using very degenerate controls

Vahagn Nersesyan

New York University Shanghai, Peoples Republic of China

In this talk, we will review some recent results on the controllability of fluid PDEs using very degenerate forces. In the case when the control force acts in the whole domain, we will see how approximate controllability can be established by applying large finite-dimensional controls on small time intervals through a carefully chosen scaling. We will also discuss some results where PDEs are controlled using degenerate forces applied only in a small region of the domain. This talk is partially based on joint papers with Manuel Rissel.

Short Bio: Vahagn Nersesyan is an Associate Professor of Mathematics at NYU Shanghai and an Associated Professor at the Courant Institute of Mathematics at NYU. He obtained his Ph.D. from the University of Paris Sud and was a Maître de Conférences at the University of Paris-Saclay (Versailles campus) until 2021. His main research interests are in the intersection of Partial Differential Equations and Probability.

Non-local problems involving the 1-Laplace operator

Chao Zhang

Harbin Institute of Technology, Peoples Republic of China

We investigate the elliptic nonlocal $(1, p)$-Laplace equation, which incorporates both the non-local one-Laplace and non-local p-Laplace operators. This talk focuses on establishing the Sobolev regularity of weak solutions to such equations, with a particular emphasis on proving their almost-Lipschitz continuity. The main analytical tools are the finite difference quotient technique, suitable energy method and tail estimates. Based on joint work with Dingding Li.

Short Bio: Chao Zhang received his B.Sc. and M.Sc. from Jilin University, and his Ph.D. from Peking University, China. He is currently a Professor at Harbin Institute of Technology. His research interests include the well-posedness and regularity of nonlinear elliptic and parabolic partial differential equations, along with the calculus of variations.

A Navier-Stokes phase-field crystal system

Cecilia Cavaterra

University of Milan, Italy

We introduce an evolution system that models a flow of colloidal particles which are suspended in an incompressible fluid and accounts for colloidal crystallisation. This system consists of the Navier-Stokes equations for the volume averaged velocity coupled with the so-called Phase-Field Crystal equation for the density deviation. We suppose that the viscosity as well as the mobility depend on the density deviation. In a periodic domain, we first show the existence of a weak solution in dimension three. Then, in dimension two, we establish the existence of a (unique) strong solution. Further issues will also be discussed.

Short Bio: Cecilia Cavaterra earned her M.Sc. in Mathematics cum laude from the Università degli Studi di Milano and her Ph.D. from the Università degli Studi di Bologna. She is currently an Associate Professor of Mathematical Analysis at the Università degli Studi di Milano. Her research primarily focuses on the regularity, stability, and long-term behaviour of solutions to nonlinear PDE systems arising from phase-field models. Her expertise also extends to inverse problems. Professor Cavaterra has authored or co-authored over forty research papers and co-edited five volumes on various topics in applied mathematics.

Two-phase micro-polar fluids: phase-field models and their analysis

Kei Fong Lam

Hong Kong Baptist University, Hong Kong S.A.R. of China

Micro-polar fluids are among the simplest cases of fluids with micro-structures, where each fluid particle has its own internal rotations. Examples include ferrofluids, blood flows, bubbly liquids and liquid crystals, all of which play significant and important roles in various industries and also in the human body. Combining the seminal work of A. Cemal Eringen and coworkers, with the diffuse interface approach for multiphase fluid flow, we present some new diffuse interface models for binary mixtures of micropolar fluids that seem to be better amenable to further analysis. Using recent advances in the mathematical analysis of such types of models, we present some novel analytical results on these new diffuse interface models for two-phase micro-polar flows. This is a joint work with Baoli Hao, Bjorn Stinner and Kin Shing Chan.

Short Bio: Kei Fong (Andrew) Lam obtained his Ph.D. at the University of Warwick, U.K., in 2014, followed by a postdoctoral position at University of Regensburg, Germany. In 2017 he returned to Hong Kong as a research assistant professor at The Chinese University of Hong Kong. Since 2020, he has been a faculty member at the Hong Kong Baptist University. His research lies in applied and computational mathematics, focusing on phase field models, Cahn-Hilliard systems, optimal control and analysis of partial differential equations.

Stability and large-time behaviour of 3D incompressible anisotropic MHD equations

Hongxia Lin

Chengdu University of Technology, Peoples Republic of China

This talk presents the stability and large-time behavior for a three-dimensional incompressible MHD equations with mixed partial dissipation. Physical experiments and numerical simulations have observed a remarkable stabilising phenomenon: a background magnetic field stabilises and dampens electrically conducting fluids. This talk intends to establish this phenomenon as a mathematically rigorous fact on a MHD system with anisotropic dissipation in $\mathbb{R}^3$. The velocity equation in this system is 3D Navier-Stokes equation with dissipation only in the x_1-direction, while the magnetic field obeys the induction equation with magnetic diffusion in two horizontal directions. We establish that any perturbation near the background magnetic field ($0, 1, 0$) is globally stable in the Sobolev setting $H^3(\mathbb{R}^3)$. Furthermore, explicit decay rates in $H^2(\mathbb{R}^3)$ are also obtained. When there is no presence of a magnetic field, the 3D anisotropic Navier-Stokes equation is not well understood and

the small data global well-posedness in $\mathbb{R}^3$ remains an intriguing open problem. Our work reveals the mechanism of how the magnetic field generates enhanced dissipation and helps to stabilise the fluid. This work is joint with Jiahong Wu and Yi Zhu (ARMA).

Short Bio: Hongxia Lin is a Professor at Chengdu University of Technology, mainly engaged in research on non-linear PDEs and mathematical theory of fluid mechanics, has achieved a series of important research results in global well-posedness and stability theory of solutions to fluid mechanics equations. She published papers in "Archive for Rational Mechanics and Analysis", "Journal of Functional Analysis", "SIAM Journal of Mathematical Analysis", "International Mathematics Research Notices", "Journal of Differential Equations", and "Nonlinearity" to cite some. She was partially supported by the National Natural Science Foundation of China, the China Postdoctoral Science Foundation General Project, and the Natural Science Foundation of Sichuan Province. She has won the "Third Prize of Sichuan Provincial Natural Science Award in 2024" and "First Prize of Basic Mathematics Award of the Second Sichuan Provincial Mathematics Association (2023)".

Desingularisation of rotationally odd-symmetric vortex pairs on the sphere

Shuanglong Li
South Western Uninversity of Finance and Economics, Peoples Republic of China

In this talk, we investigate the desingularisation of equatorially antisymmetric vortex pairs on the sphere using a dual variational method. For any given strictly increasing vorticitydependent function satisfying certain conditions, we construct a family of rotating solutions, to the incompressible Euler equations on the sphere. These solutions are obtained via a variational approach to a Casimir functional composed of the energy-impulse and the Legendre transform of the primitive function of the given vorticity prole, constrained on a suitable set. The resulting solutions are equatorially antisymmetric. As $\varepsilon \to 0$, these solutions converge, in the sense of measures, to a pair of rotating point vortices that are antisymmetric with respect to the equatorial plane. Moreover, we provide a precise characterisation of the latitudinal positions of the point vortex pair. This is a joint work with Daomin Cao & Bijun Zuo.

Short Bio: Shuanglong Li is a Lecturer at Southwestern University of Finance and Economics. He obtained his Ph.D. from the Academy of Mathematics and Systems Science, Chinese Academy of Sciences. His primary research interests lie in multi-peak solutions of elliptic equations, as well as the construction and stability of concentrated vortex solutions for steady-state Euler equations. He published several research outcomes in journals such as Nonlinearity and Calculus of Variations and Partial differential Equations.

Convergence in certain phase-field models

Yuan Chen
The Chinese University of Hong Kong, Shenzhen, Peoples Republic of China

In this talk, I'll present a general framework for justifying the convergence of L^2-gradient flows and mass-preserving L^2-gradient flows associated with a class of phase-field models, under the

assumption of well-prepared initial data. Adapted from the foundational work of Alikakos, Bates, and Chen on the Cahn-Hilliard equation in the 1990s, our approach provides a systematic method for establishing convergence to sharp interface limits. Particularly, the coercivity of the linearised operator on the kernel space plays a central role in obtaining such convergence. We introduce a variational method to establish this property, based on a robust - and, to our knowledge, novel - technique for deriving kernel estimates from an energy-based perspective. This methodology is both generic and especially well-suited to higher-order phase-field models.

Short Bio: Yuan Chen is currently working as an Assistant Professor at The Chinese University of Hong Kong, Shenzhen. Her current main research interests lie in the dynamics of phase-field models including well-posededness and convergence of the dynamics to sharp interface models.

On a quasi-incompressible diffuse interface model for two-phase incompressible viscous flows

Yadong Liu

Nanjing Normal University, Peoples Republic of China

In this talk, we will talk about a quasi-incompressible Navier-Stokes/Cahn-Hilliard coupled system, which describes the motion of two macroscopically immiscible incompressible viscous fluids. The unmatched densities case is considered and the macroscopic fluid velocity is massaveraged so the velocity field is no longer divergence-free, and the pressure enters the equation of the chemical potential. Firstly the global weak solutions of the model with regular potential and long-range interactions based on the fractional Laplacian will be introduced, via the time discretization. Moreover, the incompressible limit will be demonstrated with the help of some non-standard uniform-in-density difference controls of the pressure. Finally, we will present our recent progress on the global weak solutions under a class of singular potential, which involves delicate tail estimates to exclude possible concentrations of the potential, since no integrability of the pressure is available. This talk is based on joint work with Mingwen Fei (AHNU), Xiang Fei (AHNU), Daozhi Han (Buffalo) and Hao Wu (Fudan).

Short Bio: Since January 2024, Yadong Liu becomes a Lecturer (assistant professor) at Nanjing Normal University. Prior to it, he was a postdoctoral researcher at University of Regensburg. He finished doctoral research at Regensburg under the supervision of Prof. Dr. Helmut Abels. Yadong Liu's research lies on analysis of PDEs, involving well-posedness and singular limits of free boundary models such as fluid-structure interaction problems, two-phase flows.