IMS Workshop on PDEs (I)

December 29-31, 2016 (Thursday-Saturday)

TITLE & ABSTRACT

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Stability analysis for the incompressible Navier-Stokes equations with Navier boundary conditions

Professor Shijin DING
South China Normal University

In this talk, we discuss the stability and instability of trivial steady state to the incompressible Navier-Stokes equations (with constant density) in a two dimensional slab domain with Navier boundary conditions. A sharp critical viscosity to distinquish the stability from the instability is exactly expressed in terms of the coeffcients in the Navier boundary conditions. The linear and the nonlinear stability and instability are analyzed. The decay estimates are also given. This is a joint work with Quanrong Li and Zhouping Xin.

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The inverse scattering method and its applications

Professor Boling GUO
Institute of Applied Physics and Computational Mathematics

We introduce the inverse scattering method and the nonlinear steepest descent method for Riemann-Hilbert problems of the integrable system. Finally, the application on the orthogonal polynomials and random matrices will be mentioned.

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Hausdorff dimension of concentration for isentropic compressible Navier-Stokes equations

Professor Xianpeng HU
City University of Hong Kong

In this talk, we will discuss the concentration phenomenon of the kinetic energy $\rho|\mathbf{u}|^2$, associated to isentropic compressible Navier-Stokes equations, in $\mathbb{R}^n$ with $n = 2, 3$ and the adiabatic constant $\gamma \in [1, n/2]$. Except a space-time set with Hausdorff dimension less than or equal to $\Gamma(n) + 1$ with

$$\Gamma(n) = \max\left\{\gamma(n), n - \frac{n\gamma}{\gamma(n)+1}\right\} \quad \text{and} \quad \gamma(n) = \frac{n(n-1) - n\gamma}{n - \gamma},$$

no concentration phenomenon occurs.

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Characteristic discontinuities in nozzles

Professor Feimin HUANG
Chinese Academy of Sciences

In this talk, two phase flows for the subsonic Euler equations in an infinitely long nozzle are studied. The Bernoulli function and the Entropy at the inlet are allowed to be discontinuous.

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The Nirenberg problem and its generalizations: A unified approach

Professor Tianling JIN
The Hong Kong University of Science and Technology

The classical Nirenberg problem asks for which functions on the sphere arise as the scalar curvature of a metric that is conformal to the standard metric. In this talk, we will discuss similar questions for fractional Q-curvatures. This is equivalent to solving a family of nonlocal nonlinear equations of order less than n, where n is the dimension of the sphere. We will give a unified approach to establish existence and compactness of solutions. The main ingredient is the blow up analysis for nonlinear integral equations with critical Sobolev exponents.

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Global well-posedness to the MHD equations with partial viscosity

Professor Quansen JIU
Capital Normal University

In this talk, we will present some recent results on the global well-posedness to the MHD equations with partial viscosity . We will focus on 2D MHD with magnetic viscosity and 3D axisymmetric MHD with vertical viscosity only. The case of 2D MHD with fractional magnetic dissipation will also be discussed.

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Vanishing Viscosity Limit for Viscoelast Fluids

Professor Zhen LEI
Fudan University

The global well-posedness of 2D incompressible viscoelasticity was solved by Lin-Liu-Zhang on 2005. The corresponding elastic case was solved very recently. In this talk we report our recent result on the vanishing viscosity limit from viscoelasticity to elasticity in 2D. The limit holds uniformly for all time $t \geq 0$.

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On Kato-Ponce and related issues

Professor Dong LI
The Hong Kong University of Science and Technology

I will discuss a number of recent results on refined Kato-Ponce type inequalities and related applications in PDEs.

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Global Existence of Weak Solutions to the Barotropic Compressible Navier-Stokes Flows with Degenerate Viscosities

Professor Jing LI
Chinese Academy of Sciences

We consider the existence of global weak solutions to the barotropic compressible Navier-Stokes equations with degenerate viscosity coefficients. We construct suitable approximate system which has smooth solutions satisfying the energy inequality, the BD entropy one, and the Mellet-Vasseur type estimate. Then, after adapting the compactness results due to Bresch-Desjardins (2002, 2003) and Mellet-Vasseur (2007), we obtain the global existence of weak solutions to the barotropic compressible Navier-Stokes equations with degenerate viscosity coefficients in two or three dimensional periodic domains or whole space for large initial data. This, in particular, solved an open problem proposed by Lions (1998). This is a joint work with Prof. Zhouping Xin (CUHK).

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Global well-posedness of the primitive equations: near H^1 initial data

Professor Jinkai LI
The Chinese University of Hong Kong

In this talk, we will present the global well-posedness of strong solutions to the primitive equations with both horizontal viscosity and diffusivity for near H^1 initial data. It will be shown that, for the local well-posedness, we only need the H^1 regularity on the initial data, and the local in space type energy estimates are employed; while for the global well-posedness, due to the absence of the vertical viscosity in the momentum equation, we need a slightly higher regularity than H^1 for the initial velocity. As it will be shown in the talk, the energy estimates are carried out in three levels: the basic energy, the precise L^q estimates on the horizontal velocity, and the higher estimates.

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Using effective boundary conditions to model fast diffusion on a road in a large field

Professor Xuefeng WANG
Southern University of Science and Technology

We consider a logistic diffusion equation on the plane consisting of two components, a straight "road" and a "field", in each of which the diffusion rate differs significantly. Compared to the size of the field, the width of the road is assumed to be small. Thus in this diffusion equation multiple scales appear in two places: the spatial variable and the diffusion parameter. Such an equation is not easy to solve numerically, and it is not easy to see the effects of the road. Recently, Berestycki, Roquejoffre and Rossi provide a model which is meant to resolve these issues. In this paper we first use the idea of effective boundary conditions (EBCs) to propose, rigorously, a different model: we study the limit of the solution of the original logistic equation as the width of the road approaches zero, obtaining a limiting model, in which the road now is the horizontal line with EBCs imposed on it. This effective problem has no multiple scales and hence should be easier to solve numerically. Moreover, to see the effects of the road, we

further investigate the asymptotic propagation speed of the effective model, showing that the road indeed enhances the spreading speed along its direction, provided that the diffusion rate on the road is of the order of the reciprocal of the width of the road.

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Stability of Boundary Layers Arising from Chemotaxis Models

Professor Zhian WANG
Hong Kong Polytechnic University

We consider the stability of boundary layer solutions to a hyperbolic system transformed from a chemotaxis system modeling the initiation of tumor angiogenesis. By imposing appropriate Dirichlet boundary conditions, we show that as the chemical diffusion vanishes, the solution converges to the solution of the corresponding non-diffusive problem plus boundary layer solutions determined by the initial-boundary value problem of heat equations with exponential decay over time in the half line. We further show that the boundary layer thickness if of order the square root of the chemical diffusion and that the convergence rate of boundary layer solutions obtained is optimal.

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Axisymmetric Flow of Ideal Fluid Moving in a Narrow Domain

Professor Tak Kwong WONG
University of Hong Kong

In applications in blood flow and pipeline transport, the radial length scale of the underlying flow is usually small compared to the horizontal length scale. In this talk, we will introduce a new model called the axisymmetric hydrostatic Euler equations, which describe the leading order behavior of an ideal and axisymmetric fluid moving in such narrow channel. After providing the formal derivation, we will discuss the mathematical analysis of this model under a new sign condition. This is a joint work with Robert M. Strain.

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Incompressible limit for the compressible flow of liquid crystals in L^p type critical Besov spaces

Professor Zhengan YAO
Zhongshan University

The present paper is devoted to the compressible nematic liquid crystal flow in the whole space $R^N (N \geq 2)$. Here we concentrate on the incompressible limit in the L^p type critical Besov spaces setting. We first establish the existence of global solutions in the framework of L^p type critical spaces provided that the initial data are close to some equilibrium states. Based on the global existence, we then consider the incompressible limit problem in the ill prepared data case. We justify the low Mach number convergence to the incompressible flow of liquid crystals in proper function spaces. In addition, the accurate converge rates are obtained.

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Global solutions to a simplified Ericksen-Leslie system

Professor Yong YU
The Chinese University of Hong Kong

In this talk, we will present two solutions to the simplified Ericksen-Leslie system. These two solutions exist globally in time. But their long time behavior is quite different from each other due to the existence/non-existence of twist rate. Oscillation and concentration play key roles in these two solutions, respectively. Physically our solutions correspond to slow rotation and escape phenomenon into third dimension in liquid crystal flows.

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Wave scattering by sub-wavelength resonators and their applications

Professor Hai ZHANG
The Hong Kong University of Science and Technology

In this talk, we consider the resonant scattering by different types of sub-wavelength resonators, including Helmholtz resonators, plasmonic nanoparticles and bubbles. In each example, we derive the asymptotic for the resonances. Moreover, we show their applications in superfocusing of wave field, which is to break the Abbe's diffraction limit, and metasurfaces which is to control propagation of wave field by change of boundary conditions.