Abstracts

Existence and asymptotic behavior of positive solutions for a class of quasilinear Schrödinger equations with parameters

Yinbin Deng

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ABSTRACT

This talk is devoted to investigate the existence and asymptotic behavior of positive solutions for a class of parameter-dependent quasilinear Schrödinger equations

$$-\Delta u + V(x)u - \frac{\gamma u}{2\sqrt{1+u^2}}\Delta\sqrt{1+u^2} = \lambda|u|^{p-2}u, \quad u \in H^1(\mathbb{R}^N), \tag{1}$$

where γ, λ are positive parameters, $N \geq 3$. For a trapping potential $V(x)$ and $p \in (2, 2^*)$, by controlling the range of γ and λ, we establish the existence of positive solutions $u_{\gamma,\lambda}$ for the above problem, where $2^* = \frac{2N}{N-2}$ is critical exponent. For supper-critical case, we find a constant $p^* \in [2^*, \min\{\frac{9+2\gamma}{8+2\gamma}, \frac{2\gamma+4-2\sqrt{4+2\gamma}}{\gamma}\}2^*)$ such that equation (1) has no positive solution for all $\gamma, \lambda > 0$ if $p \geq p^*$ and $\nabla V(x)\cdot x \geq 0$ in $\mathbb{R}^N$. Furthermore, for fixed $\lambda > 0$, the asymptotic behavior of positive solutions $u_{\gamma,\lambda}$ is also obtained when $V(x)$ is a positive constant as $\gamma \to 0$.

Enhanced dissipation and transition threshold for the 3-D Poiseuille flow in a channel

Shijin Ding

South China Normal University, China

ABSTRACT

In this talk, we would like to introduce our recent results about the stability problem for the 3-D Poiseuille flow $(1-y^2, 0, 0)$ with Navier-slip boundary Conditions in a periodic channel. For the linearized Navier-Stokes equations around the 3-D Poiseuille flow, the enhanced dissipation is obtained by using the careful resolvent estimates. For the nonlinear stability transition threshold, we prove that the solution of the Navier-Stokes equations around the 3-D Poiseuille flow does not transition away from the Poiseuille flow provided that the H^2-norm of the initial perturbation and its vertical derivative is less than the $7/4$ power of the viscosity. This talk is based on a joint work with Zhilin Lin and Zhifei Zhang.

Local well-posedness of 3-d Full-Navier-Stokes equations with degenerated viscosity and far field vacuum

Qin Duan

Shenzhen University, China

ABSTRACT

In this talk, the Cauchy problem for the three-dimentional compressible Full-Navier-Stokes equations is considered. By introducing some new variables and initial compatibility conditions, we can establish the local well-posedness for a regular solution with degenerated viscosities.

Global weak solutions to the three-dimensional compressible non-Newtonian fluid

Zhenhua Guo

Northwest University, China

ABSTRACT

The equations of the three-dimensional compressible fluids with nonlinear constitutive equations are considered in a bounded domain. A solution to the initial-boundary value problem is constructed through an approximation scheme and a weak convergence method. The existence of a global variational weak solution to the three-dimensional equations of a compressible non-Newtonian fluid with large data is established.

The optimal global regularity regularity for elliptic equations which is degenerate or singular on the boundary

Huai-Yu Jian

Tsinghua University, China

ABSTRACT

In 1977, Cheng and Yau studied a Problem for Monge-Ampère Equations which may be singular or degenerate on the boundary. In fact, the Dirichlet boundary problem of P-Minkowski problem on the unit sphere (which has been be strongly studying recently) may be reduced the same Problem. Cheng and Yau obtained the existence, uniqueness and interior regularity for the solution of the Problem. In this talk, we will prove the optimal boundary regularity for the solution . As a by-product of the regularity, we improve the result of the existence. Moreover, our method can be used to study the elliptic equations from Chaplygin Gas, minimal graphs in hyperbolic space, and proper affine hypersurface which is asymptotic to a cone.

Non-existence of finite energy solution to compressible Navier-Stokes equations

Hai-Liang Li

Capital Normal University, China

ABSTRACT

It is an open problem to show the well-posedness of classical solution to compressible Navier-Stokes equations with the density possibly containing vacuum, although the same problem has been proved by Nash and Serrin in energy space in 1960s when the vacuum is excluded. In this talk, we shall prove that there does not exit any classical solution with density being compact supported to the Cauchy problem for compressible Navier-Stokes equations in energy space so long as the initial data satisfy some properties.

Global existence of weak solutions to the barotropic compressible Navier-Stokes flows with degenerate viscosities

Jing Li

Nanchang University & Academia Sinica, China

ABSTRACT

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).

Global small solutions for heat conductive compressible Navier-Stokes equations with vacuum

Jinkai Li

South China Normal University, China

ABSTRACT

In this talk, I will present the global well-posedness of strong solutions to the Cauchy problem of the heat conductive compressible Navier-Stokes equations in the presence of initial vacuum. Global existence is established under the assumption, among some other necessary regularity and compatibility conditions, that a certain scaling invariant quantity is sufficiently small, with the smallness depending only on the parameters involved in the system. Notably, the smallness assumption is imposed exclusively on the scaling invariant quantity mentioned above, and it is independent of any norms of the initial data; this is different substantially from the related existing works. The total mass can be either finite or infinite. A new equation for the density, more precisely for the cubic of the density, derived from combing the continuity and momentum equations, will be employed to get the a priori $L\infty L3$ estimate of the density.

Data-driven multiscale modeling of cell fate dynamics

Qing Nie

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ABSTRACT

Cells make fate decisions in response to dynamic environmental and pathological stimuli as well as cell-to-cell communications. Recent technological breakthroughs have enabled to gather data in previously unthinkable quantities at single cell level, starting to suggest that cell fate decision is much more complex, dynamic, and stochastic than previously recognized. Multiscale interactions, sometimes through cell-cell communications, play a critical role in cell decision-making. Dissecting cellular dynamics emerging from molecular and genomic scale in single-cell demands novel computational tools and multiscale models. In this talk, I will present our recent works on analyzing single-cell molecular data, and their connections with cellular and spatial tissue dynamics. Our mathematical approaches bring together optimization, statistical physics, ODEs/PDEs, and stochastic simulations along with machine learning techniques. By utilizing our newly developed computational tools along with their close integrations with new datasets collected from our experimental collaborators, we are able to investigate several complex systems during development and regeneration to uncover new mechanisms in cell fate determination.

Some recent results on incompressible flows with helical symmetry

Dongjuan Niu

Capital Normal University, China

ABSTRACT

Helical flows are invariant under a simultaneous rotation around a symmetry axis and translation along the same axis, which are an idealized models for the flows induced by rotating blades, such as propellers, helicopter rotors and wind turbines. In this talk, I will introduce some well-posedness theory and asymptotic behavior of incompressible flows with helical symmetry including the viscous and inviscid flows.

Rigorous derivation of non-isentropic Low Mach number Navier-Stokes equations in bounded domains

Yaobin Ou

Renmin University of China, China

ABSTRACT

In this talk, we present a result on the the low Mach limit of the full compressible Navier-Stokes equations in a three-dimensional bounded domain with smooth boundary. The uniform estimates in the Mach number for the local strong solutions are established, provided that the "well-prepared" initial condition for the solution and the slip boundary condition for the velocity and the Neumann boundary condition for the temperature are imposed. The new ingredient is that large temperature variation and positive thermal diffusion are allowed simultaneously. As a result, we can show that the target system is the low Mach number Navier-Stokes system when the Mach number vanishes.

Stability of non-smooth solitons to integrable systems

Changzheng Qu

Ningbo University, China

ABSTRACT

It is well-known that a number of integrable systems possess non-smooth solitons. In particular, the integrable Camassa-Holm-type equations admit peaked solitons, which are the weak solutions in the sense of distribution, and arise from multi-interactions among the nonlinear dispersion, various nonlinear terms and multi-component counterparts etc. In this talk, we shall be mainly concerned with orbital stability of the Camassa-Holm-type equations including their multi-component and higher-order generalizations.

Smooth transonic flows in de Laval nozzles

Chunpeng Wang

Jilin University, China

ABSTRACT

In this talk, we introduce recent joint works with Professor Zhouping Xin on smooth transonic flows in two dimensional de Laval nozzles. We consider smooth transonic potential flows whose sonic points are all exceptional. For such a smooth transonic flow, its sonic curve must be located at the throat of the nozzle and the flow is governed by a quasilinear elliptic-hyperbolic mixed type equation with degeneracy at the sonic state. It is shown that the existence of such a smooth transonic flow is determined by the geometry and the height of the nozzle at the throat.

Convection in a coupled free-flow porous media flow system

Xiaoming Wang

Southern University of Science and Technology, China

ABSTRACT

We show that the Principle of Exchange of Stability holds for convection in a layer of fluids overlaying a porous media with proper interface boundary conditions and suitable assumption on the parameters. The physically relevant small Darcy number regime as well as the dependence of the convection on various parameters will be discussed. A theory on the dependence of the depth ratio of the onset of deep convection will be put forth together with supporting numerical evidence. A decoupled uniquely solvable, unconditionally stable numerical scheme for solving the system will be presented as well.

Topology optimization, theory, numerical methods and applications

Xiaoping Wang

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ABSTRACT

Topology optimization (TO) is a promising numerical technique for optimal engineering designs in many industrial applications. It is expected that it might become an unavoidable engineering tool for many new rising technologies such as the additive manufacturing or metal 3D printing. We propose an efficient and robust iterative thresholding method for topology optimization with applications to topology optimization of the Stokes fluids system. We demonstrate mathematically that the iterative algorithm has the total energy decaying property. It is simple and easy to implement. Extensive numerical experiments in both two and three dimensions show that the proposed iteration scheme is robust, efficient and insensitive to the initial guess and the parameters in the model. Generalization to heat transfer and biomechanics problems will also be discussed.

Some progress in Leray's problem

Yun Wang

Soochow University, China

ABSTRACT

In this talk, we will discuss some progress in Leray's problem. More precisely, we prove the existence and local uniqueness of steady solutions of the Navier-Stokes equations in a pipe, for which the mass flux can be arbitrarily large and the external force can be properly large. Furthermore, we will talk about the far field behavior of the solutions.

Invariant preserving discontinuous Galerkin methods for nonlinear wave equations

Yinhua Xia

University of Science and Technology of China, China

ABSTRACT

In this talk, we will present and analyze the invariant preserving discontinuous Galerkin (DG) discretizations for nonlinear wave equations, including the Korteweg-de Vries (KdV) type equations, Camassa-Holm and Degasperis-Procesi type equations, short pulse type equation, and Ostrovsky-Vakhnenko equation. The conservative and dissipative schemes will be constructed systematically. The conservative schemes can preserve some discrete Hamiltonian invariant, while the dissipative ones guarantee the corresponding stability. Also we will introduce how to deal with the non-classical solution for some wave equations, such as peakon- and cuspon-soliton solutions, loop-solition and breather solutions, and shock solutions. Numerical experiments in different circumstances are provided to illustrate the accuracy and capability of these schemes.

Analysis on steady compressible Euler system with both fixed and free boundaries

Chunjing Xie

Shanghai Jiao Tong University, China

ABSTRACT

In this talk, we will first discuss the recent progress on subsonic steady flow in nozzles or past a body. Then we discuss the steady flows involving free boundaries.

Verification of Prandtl boundary layer expansion for the steady electrically conducting fluids with a moving physical boundary

Feng Xie

Shanghai Jiao Tong University, China

ABSTRACT

In this talk, we will discuss the validity of Prandtl boundary layer expansion for the solutions to two dimensional steady viscous incompressible MHD equations under high Reynolds numbers assumptions in a domain $\{(X, Y) \in [0, L] \times \mathbb{R}_+\}$ with a moving flat boundary $\{Y = 0\}$. As a direct consequence, the inviscid limit is thus established for the solution of 2D steady viscous incompressible MHD equations in Sobolev spaces provided that the following three assumptions hold: the hydrodynamics and magnetic Reynolds numbers take the same order in term of the reciprocal of a small parameter ϵ, the tangential component of the magnetic field does not degenerate near the boundary and the tangential component of velocity on the boundary is positive.

Subsonic and sonic jet flows

Zhouping Xin

The Chinese University of Hong Kong, Hong Kong

ABSTRACT

In this talk, I will discuss some results on jet flows for the steady compressible potential flows from a finite converging nozzle. Both subsonic and sonic jets will be considered which correspond to some free boundary problems for uniform elliptic equations and degenerate elliptic equations respectively. Formulation of the problems and the existence (and non-existence) of solutions will be discussed. Both finite jets and infinite jets can be obtained by a PDE approach and regularity and properties of the solutions will be discussed.

On the vanishing viscosity limit for a 3-D system arising from the Keller-Segel model

Wenqing Xu

California State University, Long Beach, USA

ABSTRACT

We consider the vanishing viscosity limit problem for a system arising from the Keller-Segel equations in three space dimensions. First, we construct an accurate approximate solution which incorporates the effects of boundary layers. Then we prove the structural stability of the approximate solution as the chemical diffusion coefficient tends to zero. Our approach is based on the method of matched asymptotic expansions of singular perturbation theory and the classical energy estimates. This is a joint work with Linlin Meng and Shu Wang.

On the growth and nodal sets of solutions to some elliptic equations

Xiaoping Yang

Nanjing University, China

ABSTRACT

In this talk, we will discuss the relationship between the growth and nodal sets of solutions to some elliptic equations. We will introduce various frequencies with respect to solutions of different PDEs. By using elliptic estimates and frequency functions, we will give the measure estimates for nodal sets of these solutions. We also discuss the distributions and structures of critical points of solutions to some PDEs. This is joint work with Liu Hairong and Tian Long.

Continuous weak solutions of Boussinesq equations

Liqun Zhang

Chinese Academy of Sciences, China

ABSTRACT

The Boussingesq equations was introduced in understanding the coupling nature of the thermodynamics and the fluid dynamics.

We prove the existence of continuous periodic weak solutions of the Boussinesq equations which either satisfies the prescribed kinetic energy or some other property. In particular, we recently prove the similar results when the temperature has diffusions in the model.

These are jointed works with Tao tao and also Luo Tianwen.

Radially symmetric stationary waves for the exterior problem of multidimensional Burgers equation

Huijiang Zhao

Wuhan University, China

ABSTRACT

In this talk, we are concerned with asymptotics of radially symmetric solutions for the exterior problem of multidimensional Burgers equation. Some recent results on the exstence of non-monotonic stationary waves together with their nonlinear stability will be reviewed.