Titles and Abstracts

1. Global Well-posedness of the 2-D Incompressible Navier-Stokes-Cahn-Hilliard System with Singular Free Energy Densities

Guilong Gui
Northwest University, Xi'an

This talk would focus on the subject of the 2-D incompressible Navier-Stokes-Cahn-Hilliard (NS-CH) system with singular free energy densities. Due to lack of the maximum principle for the convective Cahn-Hilliard equation (as a fourth-order parabolic equation), we construct its approximate second-order parabolic equation, and use comparison principle and the basic energy estimates to separate the solution from the singular values of the singular free energy density, where the Orlicz embedding theorem plays a key role. Based on these, we prove the global well-posedness of the Cauchy problem of the 2-D NS-CH equations with periodic domains by using energy estimates and the Logarithmic Sobolev inequality.

2. Well-posedness of Weak Solutions to Viscoelasticity

Xianpeng Hu
City University of Hong Kong

In this talk, we will discuss some recent progress in the mathematical analysis for the viscoelastic fluid flow. Global existences of weak solutions will be the main subject. The oscillation and concentration of approximating solutions are two main obstacles. A variant of "effective viscous flux" turns again to be a key tool to deal with the weak stability.

3. Diffusive Wave in the Low Mach Limit for Compressible Navier-Stokes Equations

Feimin Huang
Chinese Academy of Sciences

The low Mach limit for 1D non-isentropic compressible Navier-Stokes flow, whose density and temperature have different asymptotic states at infinite, is rigorously justified. The problems are considered on both well-prepared and ill-prepared data. For the well-prepared data, the solutions of compressible Navier-Stokes equations are shown to converge to a nonlinear diffusion wave solution globally in time as Mach number goes to zero. In particular, the velocity of diffusion wave is only driven by the variation of temperature. It is further shown that the solution of compressible Navier-Stokes system also has the same property when Mach number is small, which has never been observed before. The convergence rates on both Mach number and time are also obtained for the well-prepared data. For the ill-prepared data, the limit relies on the uniform estimates including weighted time derivatives, and an extended convergence lemma.

4. Hyperbolic Mean Curvature Flow

De-Xing Kong
Zhejiang University

Several years ago, we introduced the hyperbolic mean curvature flow and derive a new hyperbolic Monge-Ampere equation. In this talk we describe the hyperbolic mean curvature

flow and the hyperbolic Monge-Ampere equation, some of the discoveries that have been done about it, and some unresolved questions.

5. Behaviors of Navier-Stokes(Euler)-Fokker-Planck Equations

Hailiang Li
Capital Normal University

We consider the behaviors of global solutions to the initial value problems for the multi-dimensional compressible Navier-Stokes(Euler)-Fokker-Planck equations. It is shown that due the micro-macro coupling effects, the propagation of sound wave type for this NSFP or EFP system for kinetic-fluid two-phase fluid-dynamical system is observed with the wave speed determined by the two-phase fluids in terms of pointwise approach. This phenomena can no be observed for either the Fokker-Planck equation or the Euler equations with frictional damping.

6. Entropy-bounded Solutions to the Compressible Navier-Stokes Equations: with Far Field Vacuum

Jinkai Li
The Chinese University of Hong Kong

The entropy is one of the fundamental states of a fluid and, in the viscous case, the equation that it satisfies is highly singular in the region close to the vacuum. In spite of its importance in the gas dynamics, the mathematical analyses on the behavior of the entropy near the vacuum region, were rarely carried out; in particular, in the presence of vacuum, either at the far field or at some isolated interior points, it was unknown if the entropy remains its boundedness. It will be shown in this talk that the ideal gases retain their uniform boundedness of the entropy, locally or globally in time, if the vacuum occurs at the far field only and the density decays slowly enough at the far field. Precisely, we will show that the Cauchy problem to the one-dimensional full compressible Navier-Stokes equations without heat conduction have a unique local or global entropy-bounded solutions, in the presence of vacuum at the far field only. It is also shown that, different from the case that with compactly supported initial density, the compressible Navier-Stokes equations, with slowly decaying initial density, can propagate the regularities in the inhomogeneous Sobolev spaces. This is a joint work with Professor Zhouping Xin, see [1].

References

[1] Jinkai Li and Zhouping Xin: *Entropy-bounded solutions to the compressible Navier-Stokes equations: with far field vacuum*, arXiv:1710.06571

7. Some Results on the Three-Dimensional Prandtl Equations

Tianwen Luo
YMSC, Tsinghua University

Adapting the convex integration framework introduced by De Lellis-Székelyhidi, we construct Hölder continuous weak solutions to the three dimensional Prandtl system. This is a joint work with Prof. Zhouping Xin.

8. Asymptotic Stability of a Rarefaction Wave for a Symmetric Hyperbolic-parabolic System of Conservation Laws

Shinya Nishibata
Tokyo Institute of Technology, Japan

In the present talk, we discuss a large time behavior of a solution to a coupled system of viscous and inviscid conservation laws. We, mainly, talk about an asymptotic stability of a rarefaction wave under the assumption that the existence of an entropy function. This condition enables us to transform the original system to a normal form of symmetric hyperbolic-parabolic systems. In asymptotic analysis, we derive an a priori estimate by an energy method. In order to derive the basic estimate, we make use of an energy form, which is obtained by substituting a smooth approximation of the rarefaction wave in the entropy function. The symmetric system is utilized in deriving the higher estimates of the 1st and 2nd derivatives of solutions. In this procedure, we have to suppose that the stability condition hold at spatial far field.

9. Local Well-posedness of the Free Boundary Problem in Compressible Elastodynamics

Yuri Trakhinin
Sobolev Institute of Mathematics, Koptyug av. 4, 630090 Novosibirsk, Russia

We discuss recent results [2] for the free boundary problem for the equations of elastodynamics [1] governing the motion of a compressible isentropic inviscid elastic fluid. At the free boundary $\Gamma(t)$ moving with the velocity of the fluid particles the columns F_j $(j = 1, 2, 3)$ of the deformation gradient $F \in \mathbb{M}(3, 3)$ are tangent to the boundary and the pressure p vanishes outside the flow domain. We assume that the density ρ is strictly positive up to the boundary, i.e., $\rho|_\Gamma = \rho(p|_\Gamma) = \rho(0) = \bar{\rho}_0 > 0$, which is the case of liquid. We prove the local-in-time existence of a unique smooth solution of the free boundary problem provided that among three columns of the deformation gradient there are two which are non-collinear vectors at each point of the initial free boundary, i.e.,

$$\exists\ \mu, \nu \in \{1, 2, 3\},\ \mu \neq \nu\ :\quad |F_\mu \times F_\nu| \geq \delta > 0 \quad \text{on } \Gamma(0).$$

If this non-collinearity condition fails, the local-in-time existence is proved under the classical Rayleigh-Taylor sign condition

$$\frac{\partial p}{\partial N} \leq -\epsilon < 0 \quad \text{on } \Gamma(0).$$

By constructing an Hadamard-type ill-posedness example for the frozen coefficients linearized problem we show that the simultaneous failure of the non-collinearity condition and the Rayleigh-Taylor sign condition leads to Rayleigh-Taylor instability.

References

[1] Joseph D. *Fluid Dynamics of Viscoelastic Liquids*, Applied Mathematical Sciences, vol. 84, Springer-Verlag, New York, 1990.
[2] Trakhinin Y. Well-posedness of the free boundary problem in compressible elastodynamics. *J. Differential Equations*, https://doi.org/10.1016/j.jde.2017.10.005.

10. Lipschitz Continuous Subsonic-sonic Flows in General Nozzles

Chunpeng Wang
Jilin University

This talk concerns subsonic-sonic potential flows in two dimensional nozzles. For a finitely long symmetric nozzle which is suitably flat near the throat (where the cross section is

smallest) and whose wall is parallel to the symmetric axis at its two endpoints, we formulate the subsonic-sonic flow problem by prescribing the flow angle at the inlet and the outlet. It is shown that there is a unique subsonic-sonic flow whose acceleration is bounded for such a problem. Moreover, its sonic points must occur at the wall or the throat. More precisely, there exists a critical value such that the flow is sonic on the whole throat if the height of the nozzle is not greater than this critical value, while the sonic points must be located at the wall if the height is greater than this value. There are similar results for infinitely long symmetric nozzles and the asymptotic behavior at the infinity of subsonic-sonic flows are shown.

11. TBA

Xuecheng Wang
YMSC, Tsinghua University

TBA

12. Study of Boundary Layers in Compressible Flow

Yaguang Wang
Shanghai Jiaotong University

In this talk, we shall first study the behavior of viscous layers and thermal layers in viscous non-isentropic compressible flow with non-slip boundary condition when both of viscosity and heat conductivity go to zero, then present well-posedness of the boundary layer equations in the monotonic class of the velocity field. Finally, we give a blow up result when the velocity field does not satisfy the monotonic assumption.

13. Stability of Basic Wave Patterns for Some Kinetic Equations

Yi Wang
Chinese Academy of Sciences

First, I will talk about the hydrodynamic limit of the Boltzmann equation to the compressible Euler equations in the setting of 1D generic Riemann solutions, which is the superposition of three basic wave patterns to Euler equations, i.e., shock wave, rarefaction wave and contact discontinuity. Then I will show the nonlinear stability of these three basic wave patterns to the bipolar Vlasov-Poisson-Boltzmann system based on a new micro-macro type decomposition around the local Maxwellian to the system and our recent result on the time-asymptotic stability of planar rarefaction wave to three-dimensional Boltzmann equation.

14. Optimal Asymptotic Behavior of the Vorticity of Viscous Ows Past a Two-dimensional Body

Peter Wittwer
University of Geneva, Switzerland

The asymptotic behavior of the vorticity for the steady incompressible Navier-Stokes equations in a two-dimensional exterior domain is described in the case where the velocity at infinity u_∞ is nonzero. While the asymptotic behavior of the velocity field is given by the fundamental solution of the Oseen system which is obtained by the linearization of the

Navier-Stokes equation around u_∞, the asymptotic behavior of the vorticity has a power of decay that depends on the data.

References

[1] J. Math. Pures Appl. 108 (2017) 481499

15. Transonic Shocks and Mixed-Type Equations

Zhouping XIN
IMS, The Chinese University of Hong Kong

In this talk, I will discuss some progress on multi-dimensional steady compressible flows which are some of the major challenges in the mathematical theory of multi-dimensional conservation laws. We will survey studies on steady transonic flows in nozzles with variable cross sections with emphasize on flows with transonic shocks with physical boundary conditions. In particular, I will present some recent results on the Courant-Friedrich's transonic shock problem in a class of general 2-dimensional nozzles. This will be a nonlinear free boundary value problem with nonlinear boundary conditions for a mixed type system of equations. Existence of single and multiple transonic shocks will be discussed in terms of the geometry of the nozzle and the given exit pressure. Some key ideas of the analysis will be presented. Some open problems will be discussed.

16. On Global Dynamics of the Maxwell-Klein-Gordon Equations

Shiwu Yang
Beijing International Center for Mathematical Research, Peking University

On the three dimensional Euclidean space, for data with finite energy, it is well-known that the Maxwell-Klein-Gordon equations admit global solutions. However, the asymptotic behaviours of the solutions for the data with non-vanishing charge and arbitrary large size are unknown. It is conjectured that the solutions disperse as linear waves and enjoy the so-called peeling properties for pointwise estimates. In this talk, we provide a proof for this conjecture for the massless case. This is jointed work with Pin Yu.

17. On Global Solutions of 1-d Wave Equations with Applications to MHD

Pin Yu
YMSC, Tsinghua University

We will show that, although there is no decay in times for solutions to 1D wave equations, we can still prove global existences for those semilinear wave equations with null conditions. In particular, the idea can be applied to the study of Alfven waves in MHD.

18. On the Continuous Weak Solutions Of Boussinesq Equations

Liqun Zhang
Chinese Academy of Sciences

The Boussinesq 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. I shall also introduce some recent developments. This is a jointed work with Tao Tao.

19. Well-posedness of the Incompressible Euler Equations with Free Boundary

Zhifei Zhang
Peking University

I will talk about the local well-posedness of the incompressible Euler equation with free boundary in the low regularity Sobolev space. I will also present a break-down criterion in terms of the velocity, the mean curvature of free surface and Taylor sign condition.

20. Convergence to the Self-similar Solutions to the Homogeneous Boltzmann Equation

Huijiang Zhao
School of Mathematics and Statistics, Wuhan University

The Boltzmann H-theorem implies that the solution to the Boltzmann equation tends to an equilibrium, that is, a Maxwellian when time tends to infinity. This has been proved in varies settings when the initial energy is finite. However, when the initial energy is infinite, the time asymptotic state is no longer described by a Maxwellian, but a self-similar solution obtained by Bobylev-Cercignani. The purpose of this talk is to rigorously justify this for the spatially homogeneous problem with Maxwellian molecule type cross section without angular cutoff.