Workshop on Compressible Navier-Stokes Systems and Related Problems (II)

March 14-22, 2018

TITLE & ABSTRACT

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Quantitative estimates for compressible transport equations with applications to fluid mechanics

Didier BRESCH
Université Savoie Mont Blanc

These lectures aim at presenting some recent quantitative estimates for transport equations with rough, i.e. non-smooth, velocity fields. Our final goal is to use those estimates to obtain new global existence results on complex systems where the transport equation is coupled to other PDE's. We will present for reader's convenience several recent examples in fluid mechanics. These are joint works with Pierre-Emmanuel Jabin (Univ. Maryland, USA).

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Nonlinear Aggregation-Diffusion Equations in the Diffusion-dominated and Fair-competitions Regimes

Jose Antonio CARRILLO
Imperial College London

We analyse under which conditions equilibration between two competing effects, repulsion modelled by nonlinear diffusion and attraction modelled by nonlocal interaction, occurs. I will discuss several regimes that appear in aggregation diffusion problems with homogeneous kernels. I will first concentrate in the fair competition case distinguishing among porous medium like cases and fast diffusion like ones. I will discuss the main qualitative properties in terms of stationary states and minimizers of the free energies. In particular, all the porous medium cases are critical while the fast diffusion are not. In the second part, I will discuss the diffusion dominated case in which this balance leads to continuous compactly supported radially decreasing equilibrium configurations for all masses. All stationary states with suitable regularity are shown to be radially symmetric by means of continuous Steiner symmetrisation techniques. Calculus of variations tools allow us to show the existence of global minimizers among these equilibria. Finally, in the particular case of Newtonian interaction in two dimensions they lead to uniqueness of equilibria for any given mass up to translation and to the convergence of solutions of the associated nonlinear aggregation-diffusion equations towards this unique equilibrium profile up to translations as time tends to infinity. This talk is based on works in collaboration with S. Hittmeir, B. Volzone and Y. Yao and with V. Calvez and F. Hoffmann.

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On the synchronization theory of Kuramoto oscillators under the effect of inertia

Chun-Hsiung HSIA
National Taiwan University

This joint work with Bongsuk Kwon and Chang-Yeol. We investigate the synchronized collective behavior of the Kuramoto oscillators with inertia effect. Both the frequency synchronization for nonidentical case and the phase synchronization for identical case are in view. As an application of our general theory, we show the unconditional frequency synchronization for the three-nonidentical-oscillator case.

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Global well-posedness of the Boltzmann equation with large amplitude initial data

Feimin HUANG
Chinese Academy of Sciences

The global well-posedness of the Boltzmann equation with initial data of large amplitude has remained a long-standing open problem. In this lecture, I will present my recent work on the global existence and uniqueness of mild solutions to the Boltzmann equation in the whole space or torus for a class of initial data with bounded velocity-weighted L^∞ norm under some smallness condition on $L^1_x L^\infty_v$ norm as well as defect mass, energy and entropy so that the initial data allow large amplitude oscillations. Both the hard and soft potentials with angular cut-off are considered, and the large time behavior of solutions in $L^\infty_{x,v}$ norm with explicit rates of convergence is also studied.

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Global solvability of full compressible Navier-Stokes equations

Xiangdi HUANG
Chinese Academy of Sciences

For the three-dimensional full compressible NavierStokes system describing the motion of a viscous, compressible, heat-conductive, and Newtonian polytropic fluid, we establish the global existence and uniqueness of classical solutions with smooth initial data which are of small energy but possibly large oscillations where the initial density is allowed to vanish. Moreover, for the initial data, which may be discontinuous and contain vacuum states, we also obtain the global existence of weak solutions. These results generalize previous ones on classical and weak solutions for initial density being strictly away from a vacuum, and are the first for global classical and weak solutions which may have large oscillations and can contain vacuum states.

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Contraction property of Navier-Stokes shocks and uniqueness of admissible Euler shocks

Moon-Jin KANG
Sookmyung Women's University

We briefly present issues on uniqueness of entropy solutions to the compressible Euler system, which are related to the long standing conjecture: The compressible Euler equations admit a unique entropy weak solution in a class of vanishing viscosity solutions as inviscid limits of solutions to the associated viscous system that is compressible Navier-Stokes system. As a partial answer for the conjecture, we prove the contraction property for any weak perturbations of viscous shocks of the barotropic Navier-Stokes system, by constructing a weighted relative entropy and time-dependent shift. The contraction property of the shocks does not depend on the viscosity coefficient. Therefore, this provides a weak compactness for the inviscid limit problem, that is, entropy shocks for the isentropic Euler system are stable and unique in the class of weak inviscid limits of solutions to the Navier-Stokes system.

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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 sound wave type propagation of this NSFP or EFP system for two-phase fluids is observed with the wave speed determined by the two-phase fluids. This phenomena can no be observed for the pure Fokker-Planck equation.

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

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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On the non-smooth divergence free transport

Tao LUO
City University of Hong Kong

In this talk, I will discuss an example of non-uniqueness of L-infinity solutions to the non-smooth divergence free transport, joint with Colombini and Rauch. The construction is of geometric and intuitive nature.

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Structure of the kinetic region near boundary

Shigeru TAKATA
Kyoto University

In this talk, we review our recent progress on the study of a singular structure occurring in the macroscopic quantities of a rarefied gas near boundary. We discuss the discontinuity of the velocity distribution function and its relation to the diverging gradient of macroscopic quantities in approaching boundaries. We show that the diverging rate is classified by the local geometry of the boundary.

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Hydrodynamic models of collective behavior with damping and nonlocal interactions

Aneta WRÓBLEWSKA-KAMIŃSKA
Imperial College London

Hydrodynamic systems for interacting particles where attraction is taken into account by nonlocal forces derived from a potential and repulsion is introduced by local pressure arise in swarming modelling. We focus on the case where there is a balance between nonlocal attraction and local pressure in presence of confinement in the whole space. Under suitable assumptions on the potentials and the pressure functions, we show the global existence of solutions for the compressible Navier-Stokes system with linear damping and nonlocal interaction force. Moreover, we show that global weak solutions converge for large times to the set of these stationary solutions in a suitable sense. In particular cases, we can identify the limiting density uniquely as the global minimizer of the free energy with the right mass and center of mass. This is a joint result with Jose A. Carrillo and Ewelina Zatorska.

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Time-decay estimates for compressible Navier-Stokes equations without or with capillary

Jiang XU
Nanjing University of Aeronautics and Astronautics

The global existence issue for the isentropic compressible Navier-Stokes equations without or with capillary in the critical regularity framework has been addressed by R. Danchin and his collaborator more than fifteen years ago. However, whether (optimal) time-decay estimates could be shown in critical spaces and any dimensions has remained an open question. In this talk, we will report the recent efforts on that topic, which are based on joint works (see for example, [Danchin-Xu (2017)], [Xu (2017)] and [Charve-Danchin-Xu (2018)]).

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A robust and contact resolving Riemann solver

Wei YAN
Institute of Applied Physics and Computational Mathematics

In this talk, we present our recent results on solution behaviors under the strong shock interaction for moving mesh schemes based on the one-dimensional Godunov and HLLC Riemann solvers. When the grid motion velocity is close to Lagrangian one, these Godunov methods, which updates the flow parameters directly on the moving mesh without using interpolation, may suffer from numerical shock instability. In order to cure such instability, a new cell centered arbitrary Lagrangian Eulerian (ALE) algorithm is constructed for inviscid, compressible gas flows. The main feature of the algorithm is to introduce a nodal contact velocity and ensure the compatibility between edge fluxes and the nodal flow intrinsially. We establish a new two-dimensional Riemann solver based on the HLLC method (denoted by ALEHLLC-2D). The solver relaxes the condition that the contact pressures must be the same in the traditional HLLC solver and constructs discontinuous fluxes along each sampling direction of the similarity solution. The two-dimensional contact velocity of the grid node is determined via enforcing conservation of mass, momentum and total energy. The resulting ALE scheme has a node instead of grid edge conservation properties. Numerical tests are presented to demonstrate the robustness and accuracy of this new solver. Due to the multi-dimensional in formation introduced and consistency between the fluxes and nodal contact velocity, the developed ALE algorithm performs well on both quadrilateral and triangular grids and reduces numerical shock instability phenomena.

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Classification of Stationary Solutions on the Semiconductor Hydrodynamic Model with Sonic Boundary

Kaijun ZHANG
Northeast Normal University

In this talk I will give a brief introduction related to the classification problem of stationary solutions to a simplified one-dimensional hydrodynamic model for semiconductors. In particular, some results of existence and uniqueness on the subsonic solution and supersonic solution as well as transonic solution will be presented according to different cases of semiconductor doping profiles.