On Singular Limits of the Complete Euler System

Jan Brezina
Kyushu University, JAPAN

Abstract. In this talk we take the advantage of the concept of dissipative measure-valued solutions to show the rigorous derivation of the Euler-Boussinesq system that has been successfully used in various meteorological models. In particular, we show that Euler-Boussinesq system can be obtained as a singular limit of the complete Euler system. We provide two types of result-firstly, we treat the case of well-prepared initial data for any sufficiently regular bounded domain. Secondly, we use the dispersive estimates for acoustic equation to tackle the case of the ill-prepared initial data on an unbounded exterior domain.

Well-Posedness and Time-Decay Estimates of CNSK

Noboru Chikami
Osaka University, JAPAN

Abstract. We consider the compressible Navier-Stokes-Korteweg system describing the dynamics of a liquid-vapor mixture with diffuse interphase. The global solutions are established under linear stability conditions in critical Besov spaces. In particular, the sound speed may be greater than or equal to zero. By fully exploiting the parabolic property of the linearized system for all frequencies, we see that there is no loss of derivative usually induced by the pressure for the standard isentropic compressible Navier-Stokes system. This enables us to apply Banach’s fixed point theorem to show the existence of global solution. Furthermore, we obtain the optimal decay rates of the global solutions under an additional integrability assumption.

Global Well-Posedness for the 2-D Inhomogeneous Incompressible Navier-Stokes System in Critical Spaces

Guilong Gui
Northwest University, CHINA

Abstract. Without any smallness assumption, we prove in this talk the global unique solvability of the 2-D incompressible inhomogeneous Navier-Stokes equations with initial
data in the critical Besov space, which is almost the energy space in the sense that they have the same scaling in terms of this 2-D system. This is a joint work with Hammadi Abidi.

**Recent Results for Stability of the Stationary Solution of the Burgers Equation in Exterior Domains**

Itsuko Hashimoto

Kanazawa University, JAPAN

**Abstract.** I will present the recent result for stability of the stationary solution of the Burgers equation in exterior domains in $\mathbb{R}^n$. In the previous research, we considered the asymptotic behavior of radially symmetric solutions for the multi-dimensional Burgers equation in exterior domains in $\mathbb{R}^n$, and the results were restricted to stability of radially solutions within the class of spherically one dimensional flow. However, from a viewpoint of fluid dynamics, it is the rare case that such a radially symmetric stationary wave remains to be a radial one under the initial disturbance. Hence it seems to be natural to handle the non-radially symmetric perturbed fluid motion even from the radially symmetric one. In this talk we consider the asymptotic stability for stationary wave with non-radially initial perturbation on $\mathbb{R}^n$.

**Nonlinear Stability of Large Amplitude Viscous Shock Wave for the Compressible Gas**

Lin He

Sichuan University, CHINA

**Abstract.** In this talk, we discuss the nonlinear stability of large amplitude viscous shock wave for the compressible gas. In which, we do not need the pressure to be strictly convex and further more, the viscosity coefficient is assumed to be more general.

**Global Stability of Large Solutions to Compressible Navier-Stokes Equations in the Whole Space**

Jingchi Huang

Sun Yat-sen University, CHINA

**Abstract.** In this talk, we will focus on the global-in-time stability for isentropic compressible Navier-Stokes equations in the whole space. Assuming that the density is bounded in some Hölder space, we first obtain that the solution will converge to its equilibrium with an explicit rate which as the same as that for the heat equation. Based on this new decay estimates, we prove the general global-in-time stability of CNS for both 2D and 3D cases. Some related models are also considered. This is a joint work with Lingbing He, Chao Wang and Yuhui Chen.

**Long-Time Behavior or a Point Mass in a One-Dimensional Viscous Compressible Fluid**

Kai Koike

Keio University, JAPAN

**Abstract.** Vázquez and Zuazua investigated the long-time behavior of a point mass in a 1D Burgers fluid [Comm. Partial Differential Equations, 28, 1705C1738 (2003)]. In [http://arxiv.org/abs/1904.00992], we considered a similar problem for the 1D viscous compressible barotropic fluid and proved pointwise decay estimates for the fluid variables. As corollaries of these pointwise estimates, we have the following: the velocity of the point mass $V(t)$
decays with the power law $t^{-3/2}$, while in the Burgers case, it decays with the power law $t^{-1/2}$; and the $L^\infty$-norm of the fluid velocity decays as $t^{-1/2}$ both in our case and the Burgers case. We note that the faster decay rate $t^{-3/2}$ is due to the nonlinearity and the compressibility of the compressible Navier-Stokes equations. The main tool used in the proof is the pointwise decay estimates of Greens function for the system of the fluid and the point mass linearized around a constant state. In this talk, we explain these results and the idea of the proof.

**Multi-Scale Singular Limits of Rotating Boussinesq Equations**
Qiangchang Ju
Institute of Applied Physics and Computational Mathematics, CHINA

**Abstract.** We investigates the multi-scale singular limits of rotating Boussinesq equations with two small parameters. The singular limits are rigorously proved for the equations when Foude number and Rossby number tend to zero at different rates. The dynamic behavior of the system at low Foude and Rossby number is established, and the classical filtering method is developed. This is joint work with Mu, Pengcheng.

**Incompressible Limit for the Compressible Ericksen-Leslie’s Hyperbolic Liquid Crystal Model**
Fucai Li
Nanjing University, CHINA

**Abstract.** In this talk, I shall discuss the incompressible limit of the Ericksen-Leslie’s hyperbolic liquid crystal model in compressible flow. We first derive the uniform energy estimates on the Mach number $\epsilon$ for both the compressible system and its differential system with respect to time under the uniformly in $\epsilon$ small initial data. Then, we take the limit in the compressible system to establish the global classical solution of the incompressible system. Moreover, we also obtain the convergence rates for the well-prepared initial data case. This talk bases on the joint work with L. Guo, N. Jiang, Y. Luo and S. Tang.

**Global Strong Solutions to the Cauchy Problem for Planar Non-Resistive Magnetohydrodynamic Equations with Large Initial Data**
Mingjie Li
Minzu University of China, CHINA

**Abstract.** In this talk, we consider the Cauchy problem to the compressible planar magnetohydrodynamic equations without heat conduction nor magnetic diffusion, and establish the local and global existence and uniqueness of strong solutions with general large initial data. This is a joint work with Professor Jinkai Li.

**Darcy’s Law and Diffusion of a Quasi-Linear Hyperbolic-Parabolic Model for Vasculogenesis**
Qingqing Liu
South China University of Technology, CHINA

**Abstract.** This presentation is concerned with the large-time behavior of solutions to the Cauchy problem on a hyperbolic-parabolic model for vasculogenesis when initial data are around a constant equilibrium state. It turns out that both the density and the concentration
tend time-asymptotically to the linearized diffusion waves given in the sense of Darcy’s law with the rate \((1 + t)^{-5/4}\) in \(L^2\) norm and also the velocity to the corresponding asymptotic profile with the faster rate \((1 + t)^{-7/4}\) in \(L^2\) norm. All the results are based on the assumption \(bP'\bar{\rho} - \alpha \mu \bar{\rho} > 0\), which improves the smallness assumption on \(\bar{\rho}\) in previous work of Russo and Sepe.

Global Weak Solutions to the Compressible QNS Equations with Degenerate Viscosity
Boqiang Lu
Nanchang Hangkong University, CHINA

Abstract. We consider the compressible quantum Navier-Stokes (QNS) equations with degenerate viscosity in the three dimensional periodic domains. On the one hand, we consider QNS with additional damping terms. Motivated by the recent works [Li-Xin, arXiv:1504.06826] and [Antonelli-Spirito, Arch. Ration. Mech. Anal., 203(2012), 499-527], we construct a suitable approximate system which has smooth solutions satisfying the energy inequality and the BD entropy estimate. Using this system, we obtain the global existence of weak solutions to the compressible QNS equations with damping terms for large initial data. Moreover, we obtain some new a priori estimates, which can avoid using the assumption that the gradient of the velocity is a well-defined function, which is indeed used directly in [Vasseur-Yu, SIAM J. Math. Anal., 48 (2016), 1489-1511; Invent. Math., 206 (2016), 935-974]. On the other hand, in the absence of damping terms, we also prove the global existence of weak solutions to the compressible QNS equations without the lower bound assumption on the dispersive coefficient, which improves the previous result due to [Antonelli-Spirito, Arch. Ration. Mech. Anal., 203(2017), 499-527].

Homogenization of Stokes Equations in Perforated Domains: A Unified Approach
Yong Lu
Nanjing University, CHINA

Abstract. We consider the homogenization of the Stokes equations in a domain perforated with a large number of small holes which are periodically distributed. G. Allaire gave a systematic study on this problem. In this paper, we introduce a unified proof for different sizes of holes for the homogenization of the Stokes equations by employing a generalized cell problem inspired by L. Tartar.

On Pseudospectral Bound for Non-Selfadjoint Operators and Its Application
Yasunori Maekawa
Kyoto University, JAPAN

Abstract. In this talk we consider the pseudospectral bound for the operators which are written as the sum of the self-adjoint dissipative operator and the skew-adjoint operator. We present a general framework to obtain the pseudospectral bound that leads to a nontrivial dissipation. Our approach is applicable to the case when the skew-adjoint operator contains a nonlocal term, which appears naturally in the stability analysis of some viscous incompressible flows such as the Kolmogorov ow and the Lamb-Oseen ow. This talk is based on a joint work with Slim Ibrahim (UBC) and Nader Masmoudi (NYU).
Tidal Energy in Newtonian Two-Body Motion
Shuang Miao
Wuhan University, CHINA

Abstract. In this work, which is based on an essential linear analysis by Christodoulou, we study the tidal energy for the motion of two gravitating incompressible fluid balls with free boundaries, obeying the Euler-Poisson equations. The orbital energy is defined as the mechanical energy of the center of mass of the two bodies. When the fluids are replaced by point masses, according to the classical analysis of Kepler and Newton, the conic curve describing the trajectories of the bodies is a hyperbola when the orbital energy is positive and an ellipse when the orbital energy is negative. If the point masses are initially very far, then the orbital energy, which is conserved in the case of point masses, is positive corresponding to hyperbolic motion. However, in the motion of fluid balls the orbital energy is no longer conserved, as part of the conserved energy is used in deforming the boundaries of the bodies. This energy is called the tidal energy. If the tidal energy becomes larger than the total energy during the evolution, the orbital energy must change its sign, signaling a qualitative change in the orbit of the bodies. We will show that under appropriate conditions on the initial configuration this change of sign occurs. Our analysis relies on an a-priori estimates which we establish up to the point of closest approach. This is a joint work with Sohrab Shahshahani.

Short Time Regularity of Navier-Stokes Flows with Locally $L^3$ Initial Data and Applications
Hideyuki Miura
Tokyo Institute of Technology, JAPAN

Abstract. We prove short time regularity of suitable weak solutions of 3D incompressible Navier-Stokes equations near a point where the initial data is locally in $L^3$. The result is applied to the regularity problems of solutions with uniformly small local $L^3$ norms, and of forward discretely self-similar solutions. This talk is based on a joint work with Kyungkeun Kang and Tai-Peng Tsai.

Mathematical Analysis for a Model System of Complex Fluids
Naofumi Mori
Tokyo University of Marine Science and Technology, JAPAN

Abstract. Complex fluids are interesting materials and may include many examples such as shampoo, toothpaste, blood, liquid crystals, and so on. Some of them are considered as viscoelastic fluids. In this talk, we consider a model system of complex fluids first proposed by Öttinger (2005) in one-dimensional case. We observe that the model system is transformed into a hyperbolic system of balance laws. Then, we show that the system has a mathematical entropy and satisfies the stability condition first formulated by Shizuta and Kawashima (1985) for a general class of linear symmetric hyperbolic-parabolic systems. On the other hand, another condition was introduced by Umeda, Kawashima and Shizuta (1983) to derive the decay estimate of solutions for linearized symmetric hyperbolic-parabolic systems. This condition is now called craftsmanship condition. We show that the system also satisfies the craftsmanship condition by constructing the matrix $K$ concretely. As the result, by applying
these general theories for hyperbolic balance laws, we can prove the global existence and asymptotic decay of solutions to our model system. This talk is based on a joint work with Profs. Yukihito Suzuki, Masashi Ohnawa and Shuichi Kawashima.

Asymptotic Stability of Rarefaction Waves for a Hyperbolic System of Balance Laws
Kenta Nakamura
Tohoku University, JAPAN

Abstract. In this talk, we consider the rarefaction waves for a model system of hyperbolic balance laws in the whole space and in the half space. We will introduce the results concerning the asymptotic stability of rarefaction waves under smallness assumptions on the initial perturbation and on the amplitude of the waves. This talk is based on joint work with Prof. S. Kawashima, Waseda Univ.

Some Results on Incompressible Flows with Helical Symmetry
Dongjun Niu
Capital Normal University, CHINA

Abstract. In this talk, I will present some new results about the well-posedness of three-dimensional Euler equations with helical symmetry. In addition, the lower bound for the lifespan of solutions to 3D Euler equations with nonzero swirl is also mentioned.

Elementary Symmetrization of Inviscid Two-Fluid Flow Equations
Lizhi Ruan
Central China Normal University, CHINA

Abstract. This talk is concerned with two models of a compressible inviscid isentropic two-fluid flow. The first one describes the liquid-gas two-phase flow. The second one can describe the mixture of two fluids of different densities or the mixture of fluid and particles. Introducing an entropy-like function, we reduce the equations of both models to a symmetric form which looks like the compressible Euler equations written in the nonconservative form in terms of the pressure, the velocity and the entropy. Basing on existing results for the Euler equations, this gives a number of instant results for both models. In particular, we conclude that all compressive shock waves in these models exist locally in time. For the 2D case, we make the conclusion about the local-in-time existence of vortex sheets under a “supersonic” stability condition.

Derivation of the Ion Equation
Masahiro Suzuki
Nagoya Institute of Technology, JAPAN

Abstract. We consider the classical Euler-Poisson system for electrons and ions, interacting through an electrostatic field. The mass ratio of an electron and an ion is small and we establish an asymptotic expansion of solutions, where the main term is obtained from a solution to a self-consistent equation involving only the ion variables. Moreover, the validity of such an expansion is established even with ill-prepared Cauchy data, by including an additional initial layer correction. This talk is based on a joint work with Professors E. Grenier (ENS de Lyon), Y. Guo (Brown Univ.), and B. Pausader (Brown Univ.).
Global Existence and Time Decay Estimate of Solutions to the Compressible Navier-Stokes-Korteweg System Under Critical Condition
Kazuyuki Tsuda
Osaka University, JAPAN

Abstract. Global existence of solutions to the compressible Navier-Stokes-Korteweg system around a constant state is studied. This system describes liquid-vapor type two phase flow with phase transition with diffusive interface. In previous works they assume that the pressure is a monotone function for change of density similarly to the usual compressible Navier-Stokes system. On the other hand, due to phase transition the pressure is accurately non-monotone function and the linearized system loses symmetry in a critical case such that the derivative of pressure is 0 at the given constant state. It is shown that in the critical case for small data whose momentum has derivative form there exist global $L^2$ solutions and the parabolic type decay rate of the solutions is obtained. The proof is based on decomposition method for solutions to a low frequency part and a high frequency part. This work is a joint work with Prof. Takayuki Kobayashi (Osaka Univ.)

Dissipative Structure for the Symmetric Hyperbolic System with Relaxation in Whole Space
Yoshihiro Ueda
Kobe University, JAPAN

Abstract. Our main purpose of this talk is to analyze the dissipative structure for the symmetric hyperbolic system with relaxation term. If the relaxation term of the system has symmetric property, Shizuta-Kawashima(1985) and Umeda-Kawashima-Shizuta(1984) introduced the useful stability condition which induces the decay estimate for the solution of Cauchy problem. However, there are some complicated physical models which possess a non-symmetric terms and we can not apply this stability condition to these models. In this situation, we try to extend the stability condition for complicated models and get the quantitative decay estimate. Furthermore, we shall explain the new dissipative structure by using the several concrete examples.

Wave Phenomena to 3D Fluid-Particle Model
Teng Wang
Beijing University of Technology, CHINA

Abstract. Fluid-particle model is extensively used in many industries such as sprays, aerosols or sedimentation problems arising in medicine, chemical engineering, waste water treatment and Diesel engines etc. In this paper, we investigate the wave phenomena to a fluid-particle model described by the three-dimensional Vlasov-Fokker-Planck equation coupled with the compressible Navier-Stokes or Euler equations (denoted by NS/E-VFP in abbreviation). First, we prove the time-asymptotically nonlinear stability of the planar rarefaction wave for both 3D NS-VFP and E-VFP systems. Consequently, a new two-fluid model with one fluid equipped with the isothermal pressure and the degenerate viscosity coefficients depending on the corresponding density function linearly is derived from the Chapman-Enskog expansion of the Vlasov-Fokker-Planck equation around the local Maxwellian. This work is joint with Professor Hai-liang Li and Professor Yi Wang.
Global Existence of Finite Energy Weak Solution to the Compressible Euler Equations with Spherical Symmetry and Large Initial Data
Yong Wang
AMSS, the Chinese Academy of Sciences, CHINA

Abstract. For far field density $\bar{\rho} > 0$, various evidences indicate that the spherically symmetric solutions of the compressible Euler equations may blow up near the origin at certain time. In this paper, we established the global existence of finite energy weak solution by vanishing viscosity limit of weak solutions of the compressible Navier-Stokes equations with spherical symmetry and large initial data in $\mathbb{R}^N$ ($N \geq 2$) and $\bar{\rho} > 0$. This indicates that concentration is not formed in the vanishing physical viscosity limit, even though the density may blow up at certain time.

Decay Estimates of Solutions to the Incompressible Oldroyd-B Model in $\mathbb{R}^3$
Huanyao Wen
South China University of Technology, CHINA

Abstract. We consider the Cauchy problem for the incompressible Oldroyd-B model in $\mathbb{R}^3$. For the case $a = 0$, global existence results for weak solutions were derived by Lions and Masmoudi, allowing the initial data to be arbitrarily large, whereas it is not known whether this assertion is true also for a which is not zero. We obtain time decay estimates for weak solutions subject to arbitrary large data are given for the case $a = 0$. Furthermore, time-decay estimates are also given for strong solutions for a which is not zero, however, for small initial data. The decay estimates obtained are of the form that the $k^{th}$ order derivatives in $L^2$ decay as $(1 + t)^{-\frac{3}{4} - \frac{k}{2}}$ for $k = 0, 1, 2$ as $t$ goes to infinity. Note that the coupling constant $w$ does not need to be small. This talk is based on the joint work with Matthias Hieber, and Ruizhao Zi.

Axisymmetric Transonic Shock Flow in an Axisymmetric Purturbed Nozzle
Shangkun Weng
Wuhan University, CHINA

Abstract. In this talk, I will discuss the structural stability result of the spherical symmetric transonic shock solutions under the axisymmetric perturbation of the nozzle wall and also the supersonic incoming flow including the swirl component. The key issue is to find an invertible Lagrangian transformation to flatten the trajectories and kill the singularity on the axis simultaneously.

High Reynolds Numbers Limit with Physical Boundaries and the Prandtl Boundary Layer Theory for Magnetohydrodynamics
Feng Xie
Shanghai Jiaotong University, CHINA

Abstract. One important and challenging problem in magnetohydrodynamics (denoted by MHD) is to justify the high Reynolds numbers limit for the MHD equations with Prandtl boundary layer expansion where no-slip boundary condition is imposed on velocity field. Two key issues have to be addressed in this limit process: the well-posedness theory of solutions to
the MHD boundary layer equations and the justification of validity for the Prandtl boundary layer expansion. Under the assumptions that the viscosity and resistivity coefficients take the same order and the initial tangential magnetic field on the boundary does not degenerate, we not only establish the local-in-time existence, uniqueness of solution for the nonlinear MHD boundary layer equations, but prove that the Prandtl boundary layer expansion holds true for the MHD system. Moreover, a $L^\infty$ estimate is given about the error by multiscalar analysis. Compared with the well-posedness theory of the classical Prandtl equations for which the monotonicity condition of the tangential velocity plays a crucial role, such a monotonicity condition is not needed for MHD boundary layer any more. This justifies the physical understanding that the magnetic field has a stabilizing effect on MHD boundary layer in rigorous mathematics. Moreover, it is emphasized that although the justification of Prandtl boundary layer expansion is still open for the high Reynolds numbers limit of the unsteady incompressible Navier-Stokes equations with no-slip boundary condition on velocity in finite regularity functional spaces, it is well-done for MHD equations for some physical parameters regime. And some other related MHD boundary layer problems are also discussed in this talk.

**Optimal Time-Decay Rates for the 3D Compressible Magnetohydrodynamic Flows with Discontinuous Initial Data and Large Oscillations**

Yinghui Zhang
Guangxi Normal University, CHINA

**Abstract.** This paper is concerned with time-decay rates of the weak solutions to the 3D compressible magnetohydrodynamic flows with discontinuous initial data and large oscillations. The global existence of weak solutions to the Cauchy problem of the 3D compressible magnetohydrodynamic flows has been established by Suen-Hoff, under the condition that the initial energy is suitably small, the initial density is positive and essentially bounded and the gradients of initial velocity and magnetic field are bounded in $L^2$. However, to our best knowledge, so far there is no result on time-decay rates of such solutions. The main novelty of this paper is to give a positive response to this problem. More precisely, we obtain the optimal time-decay rates of the solutions in $L^r$-norm with $2/r$ and the first order derivatives of the velocity and magnetic field in $L^2$-norm when the $L^1$-norm of the initial perturbation is bounded. Moreover, we also show the lower bounds on the rates of decay.

**Global Existence of Discretely Self-Similar Solutions to the Generalized MHD System in Besov Space**

Ting Zhang
Zhejiang University, CHINA

**Abstract.** In this talk, we consider the existence of discretely self-similar solutions and self-similar solutions to the 3D generalized MHD system with fractional dissipative terms $(-\Delta)^\alpha v$ and $(-\Delta)^\alpha H$, $\frac{7}{5} < \alpha < \frac{5}{4}$. Using the Brouwer fixed-point theorem and Littlewood analysis method, we prove the global existence of discretely self-similar solutions and self-similar solutions to the 3D generalized MHD system when the initial data are in the critical space $L^{\frac{2}{2\alpha-1}}$ or the critical Besov space $B_p, \infty^{1-2\alpha+\frac{3}{p}}$, where $\frac{2}{2\alpha-1} < p < \frac{6}{5-4\alpha}$, $p < \frac{3}{\alpha-1}$ when $\frac{7}{6} \leq \alpha < \frac{5}{4}$. (Joint work with Jingjing Zhang).