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ABSTRACT

Motion of a Vortex Filament in an External Flow

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Vortices have been one of the central research topics in fluid mechanics for a long time. This is partly due to the fact that vortices offer a wide range of interesting problems both in theory and application.

In this talk, we will be focusing on what is called a vortex filament. A vortex filament is a space curve on which the vorticity of the fluid is concentrated. The swirling motion that the filament induces to the surrounding fluid, in return, causes the filament to change shapes and move around in the fluid. Under the assumption that the fluid is incompressible and inviscid, a vortex filament keeps its thin structure throughout the motion, and can be realized as a motion of a curve in the three-dimensional Euclidean space.

The problem we consider in this talk describes the motion of a vortex filament moving under the influence of external flow. Time-local existence and uniqueness of the solution for an initial value problem describing such motion will be presented.

Two-dimensional Impinging Jets in Hydrodynamic Rotational Flows

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In this talk, we will discuss the well-posedness of the impinging jets in steady incompressible, rotational, plane flows. More precisely, given a mass flux and a vorticity of the incoming flows in the inlet of the nozzle, there exists a unique smooth impinging plane jet. Moreover, there exists a smooth free streamline, which goes to infinity and initiates at the endpoint of the nozzle smoothly. In addition, asymptotic behavior in upstream and downstream, uniform direction and other properties of the impinging jet are also obtained.

On Free Boundary Value Problem for Compressible Navier-Stokes Equations with Temperature dependent Heat Conductivity

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We prove existence of global strong solution to free boundary value problem in one-dimensional compressible Navier-Stokes system for the viscous and heat conducting ideal polytropic gas flow, when heat conductivity depends on temperature in power law of Chapman-Enskog. In addition, the free boundary is shown to expand outward at an algebraic rate in time.

Free boundary problem of compressible Euler equations with general initial densities

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In this talk, I will show a priori estimates for the three-dimensional compressible Euler equations with moving physical vacuum boundary, the γ-gas law equation of state for γ=2 and the general initial density ρ0∈H5. I derive a mixed space-time interpolation inequality which play a vital role in the energy estimates and obtain some extra estimates for the space-time derivatives of the velocity in L3, which is different from the known results.

On Linear Instability and Stability of the Rayleigh-Taylor Problem in Magnetohydrodynamics

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We investigate the stabilizing effects of the magnetic fields in the linearized magnetic Rayleigh-Taylor (RT) problem of a nonhomogeneous incompressible viscous magnetohydrodynamic fluid of zero resistivity in the presence of a uniform gravitational field in a three-dimensional bounded domain, in which the velocity of the fluid is non-slip on the boundary. By adapting a modified variational method and careful deriving \emph{a priori} estimates, we establish a criterion for the instability/stability of the linearized problem around a magnetic RT equilibrium state. In the criterion, we find a new phenomenon that a sufficiently strong horizontal magnetic field has the same stabilizing effect as that of the vertical magnetic field on growth of the magnetic RT instability. In addition, we further study the corresponding compressible case, i.e., the Parker (or magnetic buoyancy) problem, for which the strength of a horizontal magnetic field decreases with height, and also show the stabilizing effect of a sufficiently large magnetic field.

Quasineutral limit of the two-fluid Euler-Poisson system in a domain with boundary

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We give the rigorous proof for the quasineutral limit of the two-fluid Euler-Poisson system in a domain with boundary. A non-penetration boundary condition for velocity is considered. The existence and stability of the bondary layer is studied as well.

On some two phase problem for compressible-compressible viscous fluid flow

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In this talk, we consider some two phase problem for compressible-compressible viscous fluid flow. In order to prove local well-posedness, the generation of analytic semigroup for linearlized problem and its maximal L_p-L_q regularity theorem are needed in our method. The key step to prove them is to prove the existence of $\mathcal{R}$-bounded solution operator to the resolvent problem corresponding the linearized problem. In this talk, we shall report the existence of $\mathcal{R}$-bounded solution operator for the resolvent problem. Moreover as its application, we shall introduce the local well-posedness for our problem.

The non-cutoff Vlasov-Maxwell-Boltzmann System with weak angular singularity

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We establish the global existence of solutions near a global Maxwellian to the Cauchy problem of the non-cutoff Vlasov-Maxwell-Boltzmann system with weak angular singularity, i.e. $0<s<1/2$. This extends the work (Duan et al. in Kinet Relat Models 6(1):159-204, 2013), in which the strong angular singularity $1/2 \leq s<1$ must be satisfied.

Compactness Criteria for the Resolvent of Fokker-Planck operator

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In this talk we study the spectral property of the Fokker-Planck operator with potential. By virtue of a multiplier method, we obtain the compactness criteria for its resolvent, based on some kind of sign conditions on the Hessian matrix of the potential.

On stability of steady circular flows in a two-dimensional exterior domain

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In this talk we discuss the stability of some explicit stationary solutions to the Navier-Stokes equations in a two-dimensional exterior disk. These explicit solutions describe a typical circular ow around a rotating obstacle and decay at spatial infinity in a scale-critical order.
Due to the difficulty arising from the absence of the Hardy inequality, so far little is known about the stability of stationary solutions in scale-critical spaces to the two-dimensional Navier-Stokes equations in unbounded domains. In this talk we will show that if these explicit solutions are small enough then they are asymptotically stable with respect to small L^2 perturbations. The key step of the proof is the spectral and resolvent analysis for the linearized operator, which is realized as a relatively compact perturbation of the standard Stokes operator. In particular, we will give a characterization on the discrete spectrum in terms of zero points of some analytic functions, which enables us to exclude the possibility of the presence of the unstable spectrum for the linearized operator at least when the explicit stationary solution is small enough.

Degenerate boundary layers for a system of viscous conservation laws

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In this talk, we consider the existence and asymptotic stability of the stationary solution for system of viscous conservation laws in one-dimensional half space. We especially consider the degenerate stationary solution which verifies algebraic convergence as the space variable tends to infinity. With the aid of the center manifold theory, the existence of the degenerate stationary solution is proved under the situation that one characteristic is zero and the other characteristics are negative. Asymptotic stability of the degenerate stationary solution is also proved in an algebraically weighted Sobolev space provided that the weight exponent is less than 5. The stability analysis is based on deriving the a priori estimate by using the weighted energy method combined with the Hardy type inequality with the best possible constant.

Global smooth solutions to vacuum free boundary problem of 1-D full Navier-Stokes equations with large data

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In this talk, I'll present some recent results on the global existence of smooth solutions to the vacuum free boundary problem for one-dimensional full compressible Navier-Stokes equations with large initial data. The fluids are initially filled up in a finite interval and connect to the vacuum continuously at the free boundary. Using the method of Lagrangian particle path, we derive some point-wise estimates and energy estimates for the smooth solutions. The main difficulty lies in the degeneracy of the system near the free boundary. Compared with previous results on global weak or strong solutions, the novelty of this result is the global-in-time smoothness of solutions up to the free surface.

Vortex Sheet on Invscid Two-phase Flow Model

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In this talk, the vortex sheet solutions are considered for the inviscid liquid-gas two-phase flow. In particular, the linear stability of vortex sheets in two spatial dimensions is established for both constant and variable coefficients. The linearized problem of vortex sheet solutions with constant coefficients is studied by means of Fourier analysis, normal mode analysis and Kreiss' symmetrizer, while the linear stability with variable coefficients is obtained by Bony-Meyer's paradifferential calculus theory. The linear stability is crucial to the existence of vortex sheet solutions of the nonlinear problem. This work is joint with Prof. Dehua Wang, Dr. Shangkun Weng and Prof. Changjiang Zhu.

Time-periodic solutions to the drift-diffusion model for semiconductors

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We study the existence and the asymptotic stability of time-periodic solutions to the drift-diffusion model for semiconductors. If alternating-current voltage is applied to PN-junction diodes, a

time-periodic current flow is observed. The main purpose of this talk is mathematical analysis on this periodic flow. We construct a time-periodic solution by utilizing the Galerkin method. The solution is unique in a neighborhood of a thermal equilibrium, and it is globally stable. Proofs of the uniqueness and the stability are based on the energy method employing an energy form.

Stability condition for a system of delay-differential equations and its application

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In this talk, we discuss a system of delay-differential equations(DDEs).For a single equation of DDEs, we had already known the stability condition to obtain the asymptotic stability result. On the other hand, we have few results of the stability condition for a system of DDEs. Under this situation, we derive some stabilitycondition for the system of DDEs and apply this result to the system of PDEs with delay terms.This talk is based on a joint work with Gilbert R. Peralta (University of the Philippines Baguio).

On spherically symmetric motions of a viscous heat-conducting and self-gravitating gas

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We consider a system of equations describing spherically symmetric motions of a viscous, heat-conducting and self-gravitating gas bounded by the free-surface. We show first the temporally global solvability of our problems without any restriction on the size of the initial data. Second the large-time behaviour of the flow will be investigated by getting uniform in time a priori estimates of the solution under a certain degree of, but physically plausible restriction. The asymptotic profile of the flow is given by a particular solution of the corresponding stationary problem.

Global Smooth Supersonic Flows in Infinite Expanding Nozzles

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This talk concerns smooth supersonic potential flows with Lipschitz continuous speed in two-dimensional infinite expanding nozzles. The flow satisfies the slip condition on the walls and the flow velocity is prescribed at the inlet. First, it is proved that if the incoming flow is away from the sonic and vacuum state and its streamlines diverge at the inlet, then a flow in a straight nozzle never approaches the sonic and vacuum state in any bounded region. Furthermore, a sufficient and necessary condition of the incoming flow at the inlet is derived for the existence of a global smooth supersonic flow in a straight nozzle. Then, it is shown that for each incoming flow satisfying this condition, there exists uniquely a global smooth supersonic flow in a symmetric nozzle with convex upper wall. It is noted that such a flow may contain a vacuum. If there is a vacuum for a global smooth transonic flow in a symmetric nozzle with convex upper wall, it is proved that for the symmetric upper part of the flow, the first vacuum point along the symmetric axis must be located at the upper wall and the set of vacuum points is the closed domain bounded by the tangent half-line of the upper wall at this point to downstream and the upper wall after this point. Moreover, the flow speed is globally Lipschitz continuous in the nozzle, and on the boundary between the gas and the vacuum, the flow velocity is along this boundary and the normal derivatives of the flow speed and the square of the sound speed both are zero.

Global Large Solutions to a Viscous and Heat-Conducting Gas with Temperature Dependent Viscosity

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The construction of global large solutions to a one-dimensional viscous and heat-conducting ideal polytropic gas with temperature-dependent transport coefficients and general adiabatic exponent will be presented.

Nonlinear Diffusive Phenomenon in the Low Mach Number Limit for the Full Compressible Navier-Stokes Equations

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The low Mach number limit for the full compressible Navier-Stokes flows, which density and temperature have the different asymmetric states at infinite, is rigorously justified. The problems are considered on both cases of ill-papered data and well-papered data. For case of ill-prepared data, the limit relays on the uniform estimates including all orders of weighted time derivatives, and an extended convergence lemma which can handle the different asymptotic states at infinity. For the case of well-prepared data, the solutions of full compressible Navier-Stokes equations is proved to converge to a nonlinear diffusion waves solution global in time as Mach number goes to zero. The convergence rates on both Mach number and time are also obtained. This is a joint work with Feimin Huang, Tianyi Wang.

Global solutions of the drift-flux model with slip

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Drift-flux model is one of the commonly used models nowadays for the prediction of various two-phase flows. In this talk, I will talk about the global existence of weak solutions of the model with slip. The two phases are allowed to flow with unequal fluid velocity. It's joint with Prof. Steinar Evje (UiS, Norway).

The Vlasov-Poisson-Boltzmann system for the whole range of cutoff soft potentials

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The dynamics of dilute electrons can be modeled by the fundamental one-species Vlasov-Poisson-Boltzmann system which describes mutual interactions of the electrons through collisions in the self-consistent electrostatic field. For cutoff intermolecular interactions, although there are some progress on the construction of global smooth solutions to its Cauchy problem near Maxwellians recently, the problem for the case of very soft potentials remains unsolved. By introducing a new time-velocity weighted energy method and based on some new optimal temporal decay estimates on the solution itself and some of its derivatives with respect to both the spatial and the velocity variables, it is shown in this manuscript that the Cauchy problem of the one-species Vlasov-Poisson-Boltzmann system for all cutoff soft potentials does exist a unique global smooth solution for general initial perturbation which is assumed to be small in certain weighted Sobolev spaces. Our approach applies also to the case of cutoff hard potentials and thus provides a satisfactory global well-posedness theory to the one-species Vlasov-Poisson-Boltzmann system near Maxwellians for the whole range of cutoff intermolecular interactions in the perturbative framework. This is a joint work with Dr. Linjie Xiong and Prof. Huijiang Zhao.

The frequency-localization time-decay property and its

application to dissipative systems of regularity-loss type

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Dissipative hyperbolic systems of regularity-loss have been recently received increasing attention. Usually, extra higher regularity is assumed to obtain the optimal decay estimates, in comparison with that for the global-in-time existence of solutions. Recently, we have developed a new frequency-localization time-decay property such that the extra higher regularity is no longer needed. As applications, we investigate the minimal decay regularity for Timoshenko and Euler-Maxwell systems.

This talk is based on the recent works with Professor Shuichi Kawashima.

Quantitative evaluation for the viscous incompressible two-phase flow by finite element based level set method

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In this talk quantitative evaluation for numerical solutions of viscous incompressible two-phase flow, in particular two dimensional rising bubble dynamics, is discussed. The motion of viscous incompressible two-phase flow is formulated by a free boundary value problem of the Navier-Stokes equations.

We mainly interested in the deformation of the interface between two fluids (shape of rising bubble). Numerical computation is one of the reasonable ways to observe the process of deformation of the interface. Since there are no exact solutions for the rising bubble problem, it is impossible to verify numerical solutions by virtue of mathematical solutions. Therefore it seems to be worth well to verify numerical solutions by quantitative comparisons by using the other numerical solutions.

Hysing *et al*. (2009) proposed a *quantitative benchmark problem* for the two dimensional rising bubble problem. They observed three different numerical solutions for the above benchmark problem by *circularity*, *centroid vector* and *rise-velocity*. Later on Hysing *et al*. (2009), Doeyux *et al*. (2013) tried the same benchmark problem. We also try the same benchmark problem and report our numerical results. In addition to the previous results, we also observe horizontal symmetricity of the motion and volume of bubble.

Our computational method is finite element based level set method with reinitialization of the level set function, which is based on nonlinear elliptic partial differential equation (Basting & Kuzmin 2013).

This talk is based on a joint work with Katsuhi Ohmori (University of Toyama, JAPAN).

A local analysis of the incompressible Euler flow

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In the talk we analyze local behavior of the incompressible Euler flow. Recently, some researchers made breakthrough in the incompressible Euler flow study field (Chae 2008, Luo-Hou 2014, Bourgain-Li 2015 and Kiselev-Sverak 2014). They analyzed local behavior of the Euler flow near the hyperbolic flow configuraion. We explain our recent work (more or less) related to their outstanding results.

Global solution to the relativistic Boltzmann equation

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In this talk we will discuss about global existence, large time behavior and regularity of the solutions to the the relativistic Boltzmann equation.

Spectrum Structure and Behaviors of the Vlasov-Maxwell-Boltzmann Systems

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The spectrum structures and behaviors of the Vlasov-Maxwell-Boltzmann (VMB) systems for both two species and one species are studied in this paper. The analysis shows the effect of the Lorentz force induced by the electro-magnetic field leads to some different structure of spectrum from the classical Boltzmann equation and the closely related Vlasov-Poisson-Boltzmann system. And the significant difference between the two-species VMB model and one-species VMB model are given. The structure in high frequency illustrates the hyperbolic structure of the Maxwell equation. Furthermore, the long time behaviors and the optimal convergence rates to the equilibrium of the Vlasov-Maxwell-Boltzmann systems for both two species and one species are established based on the spectrum analysis.

Global solutions to the Oldroyd-B model with a class of large initial data

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Consider a global wellposed problem for the incompressible Oldroyd-B model. It is shown that this set of equations admits a unique global solution provided the initial horizontal velocity u^h_0, the product $\om u^d_0$ of the coupling parameter $\om$ and initial the vertical velocity u^d_0, and initial symmetric tensor of constrains τ_0 are sufficient small in the scaling invariant Besov space $\dot{B}^{\fr{d}{2}-1}_{2,1}\times\dot{B}^{\fr{d}{2}}_{2,1}, d\ge2$. In particular, the result implies the global well-posedness of Oldroyd-B model with large initial vertical velocity u_0^d.