华南数学应用与交叉研究中心
South China Research Center for Applied Mathematics and Interdisciplinary Studies

CAMIS-SCNU Forum

大气海洋非线性偏微分方程及其相关论坛：确定型方程

Forum in Nonlinear PDEs from Oceanic and Atmospheric Dynamics and Related Topics

Brochure

会议手册

South China Research Center for Applied Mathematics
and Interdisciplinary Studies (CAMIS), South China Normal University
华南师范大学华南数学应用与交叉研究中心

Guangzhou, China

November 28-30, 2018

Address: Zhong Shan Avenue West 55, Tianhe District, Guangzhou 510631, China
地址：广东省广州市天河区中山大道西55号 邮编：510631
Website: http://camis.scnu.edu.cn/

1. Information

（1）Organizing Committee

Shijin Ding（丁时进）： South China Normal University

Jinkai Li（李进开）： South China Normal University

Xiaoming Wang（王晓明）： Southern University of Science and Technology

Zhouping Xin （辛周平）： The Chinese University of Hong Kong

（2）Address

① **Accommodation:** Huashi Building Hotel (华师大厦酒店)

② **Hotel Address:** Zhongshan Avenue West No. 69, Tianhe District, Guangzhou 510631, China

(广州市中山大道西 69 号华师大厦酒店（原华师粤海酒店）)

③ **Talk Avenue:** South China Research Center for Applied Mathematics and Interdisciplinary Studies (CAMIS), South China Normal University

（华南师范大学华南数学应用与交叉研究中心）

（3）Map: Huashi Hotel ---- CAMIS

2. Timetable

	November 28	November 29	November 30
8:30--9:30	Edriss Titi	Claude Bardos	Wendong Wang
9:30--10:00	Tea/Coffee Break	Tea/Coffee Break	Tea/Coffee Break
10:00--11:00	Yinnian He	Dongjuan Niu	Chun-Hsiung Hsia
11:00--12:00	Takahito Kashiwabara	Xiaojing Xu	Fei Jiang
12:00--14:00	Lunch	Lunch	Lunch
14:00--15:00	Michele Coti-Zelati	Guilong Gui	Free Discussion
15:00--15:30	Tea/Coffee Break	Tea/Coffee Break	
15:30--16:30	Ruizhao Zi	Yuan Yuan	
16:30--17:30	Aibin Zang	Shangkun Weng	
18:00--20:00	Dinner	Dinner	Dinner

3. Schedule

November 28	
Session Chair: Jinkai Li	
8:30--9:30	*Analysis of oceanic and tropical atmospheric models with moisture: global regularity, finite-time blowup and singular limit behavior* Edriss S. Titi (Texas A&M University and The Weizmann Institute of Science)
9:30--10:00	Tea/Coffee Break
10:00--11:00	*Decoupled finite element methods for the 3D primitive equations of ocean* Yinnian He (何银年 Xi'an Jiaotong University)
11:00--12:00	*Semigroup and maximal regularity approach to the primitive equations* Takahito Kashiwabara (The University of Tokyo)
12:00--14:00	Lunch （Huashi Building Hotel 华师大厦酒店一楼）
Session Chair: Xiaoming Wang	
14:00--15:00	*Metastability results for the Navier-Stokes equations and related models* Michele Coti-Zelati (Imperial College)
15:00--15:30	Tea/Coffee Break
15:30--16:30	*Convergence to equilibrium for the solution of the full compressible Navier-Stokes equations* Ruzhao Zi (訾瑞昭 Central China Normal University)
16:30--17:30	*Euler system is approximated by turbulence model with Dirichlet boundary conditions* Aibin Zang (臧爱彬 Yichun University)
18:00--20:00	Dinner (Tao Yuan 陶园餐厅二楼)

November 29	
Session Chair: Edriss S. Titi	
8:30--9:30	*About stability and instability results for 2D Euler equations* Claude Bardos (Universit e Denis Diderot Paris)
9:30--10:00	Tea/Coffee Break
10:00--11:00	*Some results on incompressible fluids with helical symmetry* Dongjuan Niu (牛冬娟 Capital Normal University)
11:00--12:00	*The well-posedness of 2D Boussinesq system* Xiaojing Xu (许孝精 Beijing Normal University)
12:00--14:00	Lunch （Huashi Building Hotel 华师大厦酒店一楼）
Session Chair: Dongjuan Niu	
14:00--15:00	*Global well-posedness of viscous surface waves without surface tension revisited* Guilong Gui (桂贵龙 Northwest University)
15:00--15:30	Tea/Coffee Break
15:30--16:30	*On the free boundary problem of the non-isentropic compressible Naiver-Stokes equations in 3D* Yuan Yuan (袁源 South China Normal University)
16:30--17:30	*A deformation-curl decomposition to the steady Euler equations* Shangkun Weng (翁上昆 Wuhan University)
18:00--20:00	Dinner (Tao Yuan 陶园餐厅二楼)

November 30	
Session Chair: Guilong Gui	
8:30--9:30	*On the boundary layer equations from the Navier-Stokes equations and MHD equations* Wendong Wang (王文栋 Dalian University of Technology)
9:30--10:00	Tea/Coffee Break
10:00--11:00	*On the mathematical analysis of the synchronization theory with time-delayed effect* Chun-Hsiung Hsia (夏俊雄 National Taiwan University)
11:00--12:00	*Instability of the abstract Rayleigh--Taylor problem and applications* Fei Jiang (江飞 Fuzhou University)
12:00--14:00	Lunch (Tao Yuan 陶园餐厅二楼)
14:00--17:30	Free Discussion
18:00--20:00	Dinner (Tao Yuan 陶园餐厅二楼)

4. Abstract & Title

About stability and instability results for 2D Euler equations

Claude Bardos (Universit e Denis Diderot Paris)

In the recent years many results have contributed to our understanding (or lack of understanding) of phenomena that may be described by the 2d incompressible Euler equation. This would include examples as diverse as the Jupiter red spot, the shape of the hurricanes or the wake behind wing. In this spirit I would like to compare the Arnold stability criteria, the stability or unstability of the wake behind a wing in relation either with the Kelvin Helmholtz instability or with the zero viscosity limit in presence of boundary effects of the solutions of the Navier stokes equations.

Metastability results for the Navier-Stokes equations and related models

Michele Coti-Zelati (Imperial College)

We study diffusion and mixing in the incompressible Navier-Stokes equations and related scalar models. In this setting, mixing is a purely advective effect which causes a transfer of energy to high frequency. In turn, mixing acts to enhance the dissipative forces, giving rise to what we refer to as enhanced dissipation: this can be understood by the identification of a time-scale faster than the purely diffusive one. We will present two results:

(1) a general quantitative criterion that links mixing rates (in terms of decay of negative Sobolev norms) to enhanced dissipation time-scales, with several applications including passive scalar evolution in both planar and radial settings, fractional diffusion, and Anosov flows.

(2) a precise identification of the enhanced dissipation time-scale for the Navier-Stokes equations linearized around the Poiseuille flow, along with metastability results and nonlinear transition stability thresholds.

Global well-posedness of viscous surface waves without surface tension revisited

Guilong Gui (桂贵龙 Northwest University)

Consideration in this talk is a viscous fluid of finite depth below the air, occupying a three-dimensional domain bounded below by a fixed solid boundary and above by a free moving boundary. The fluid dynamics are governed by the gravity-driven incompressible Navier-Stokes equations (without the effect of surface tension on the free surface), which results in the anisotropic decay or growth of the free surface. By using the balance between the anisotropic decay and growth estimates, we prove global well-posedness of the surface wave problem with small initial puterbation near equilibrium.

Decoupled finite element methods for the 3D primitive equations of ocean

Yinnian He (何银年 Xi'an Jiaotong University)

In this talk, two decoupled finite element methods are proposed for solving the 3D primitive equations of ocean. Based on the finite element approximation, optimal error estimates are given under the convergence condition. And the detailed algorithms are given in the section of numerical tests. Further, numerical calculations are implemented to validate theoretical analysis and more calculations are implemented for a more meaningful problem. For both theoretical and numerical points of view, the proposed decoupled finite element methods are the effective strategies to solve the 3D primitive equations of ocean.

On the mathematical analysis of the synchronization theory with time-delayed effect

Chun-Hsiung Hsia (夏俊雄 National Taiwan University)

This is joint work with Bongsuk Kwon, Chang-Yeol Jung and Yoshihiro Ueda. We investigate the synchronized collective behavior of the Kuramoto oscillators with time-delayed interactions and frustration effect. Both the phase synchronization and frequency synchronization are in view.

Instability of the abstract Rayleigh--Taylor problem and applications

Fei Jiang (江飞 Fuzhou University)

We prove the existence of a unique unstable strong solution in the sense of L^1-norm for an abstract Rayleigh--Taylor (RT) problem of stratified viscous fluids in Lagrangian coordinates based on a bootstrap instability method. In the proof, we develop a method to modify the initial data of the linearized abstract RT problem based on an existence theory of unique solution of stratified (steady) Stokes problem and an iterative technique, so that the obtained modified initial data satisfy necessary compatibility conditions of the (original) abstract RT problem. Applying an inverse transformation of Lagrangian coordinates to the obtained unstable solution, and then taking proper value of parameters, we can further get unstable solutions for the RT problems in viscoelastic fluids, magnetohydrodynamics (MHD) fluids with zero resistivity and pure viscous fluids (with or without interface intension) in Eulerian coordinates. Our results can be also extended to the corresponding inhomogeneous case (without interface).

Semigroup and maximal regularity approach to the primitive equations

Takahito Kashiwabara (The University of Tokyo)

We review the results so far obtained for the primitive equations (PEs), which describe large-scale motion of ocean or atmosphere. Most of them are concerned with the global-in-time existence and uniqueness of a strong solution provided by an analytic semigroup approach or by a maximal-regularity theory. In particular, investigation of the linear part of the PEs, i.e., the \emph{hydrostatic Stokes operator}, has a central importance. We will first present the L^p-theory where the strong solution is constructed for initial data belonging to $H^{2/p,p}$. We show that the solution becomes C^∞ (even real analytic) in x and t after initial time. Then the endpoint case $p = \infty$ (more precisely, an anisotropic space $L^\infty_{xy}L^p_z$ will be considered) is discussed, which requires more delicate arguments due to the lack of boundedness in L^∞ of the hydrostatic Helmholtz projector. If time permits, justification of hydrostatic approximation in the L^p-setting, that is, convergence from the Navier--Stokes equations to the PEs in the zero aspect-ratio limit, will also be mentioned.

Some results on incompressible fluids with helical symmetry

Dongjuan Niu (Capital Normal University)

In this talk, I will present the lower bounds of the lifespan of the solutions to the incompressible Euler equations with helical symmetry. It is the first results to the three-dimensional incompressible helical flows with the nonzero helical swirl. It is a joint work with A. Swierczewska. Gwiazda.

Analysis of oceanic and tropical atmospheric models with moisture: global regularity, finite-time blowup and singular limit behavior

Edriss S. Titi (Texas A&M University&The Weizmann Institute of Science)

In this talk I will present some recent results concerning global regularity of certain geophysical models. This will include the three-dimensional primitive equations with various anisotropic viscosity and turbulence mixing diffusion, and certain tropical atmospheric models with moisture. Moreover, I will show that in the non-viscous (inviscid) case there is a one-parameter family of initial data for which the corresponding smooth solutions of the primitive equations develop finite-time singularities (blowup).

Capitalizing on the above results, I will also provide rigorous justification of the derivation ofthe Primitive Equations of planetary scale oceanic dynamics from the three-dimensional Navier-Stokes equations as the vanishing limit of the small aspect ratio of the depth to horizontal width. Specifically, I will show that the Navier-Stokes equations, after being scaled appropriately by the small aspect ratio parameter of the physical domain, converge strongly to the primitive equations, globally and uniformly in time, and the convergence rate is of the same order as the aspect ratio parameter. Furthermore, I will also consider the singular limit behavior of a tropical atmospheric

model with moisture, as $\varepsilon \to 0$, where $\varepsilon > 0$ is a moisture phase transition small convective adjustment relaxation time parameter.

On the boundary layer equations from the Navier-Stokes equations and MHD equations

Wendong Wang (王文栋 Dalian University of Technology)

In this talk, we will recall some known results on boundary layer equations from the Navier-Stokes equations and MHD equations including the local wellposedness theory and the vanishing viscosity limit analysis. We also introduce some recent developments on this topic. This is joint works with Y.-J. Li, T. Tao and Z.-F. Zhang.

A deformation-curl decomposition to the steady Euler equations

Shangkun Weng (翁上昆 Wuhan University)

This talk will discuss the hyperbolic-elliptic coupled structure in steady compressible Euler equations. We will give a deformation-curl decomposition of 3D steady Euler system. This is based on the reformulation of the density equation by using the Bernoulli's law. This is joint with Prof. Zhouping Xin.

The well-posedness of 2D Boussinesq system

Xiaojing Xu (许孝精 Beijing Normal University)

In this talk, I shall give some results on the global well-posedness of 2D Boussinesq equations with some kinds of dissipation terms, including the subcritical or critical fractional Laplacian, damping term, anisotropic dissipation and viscosity depending on temperature， and with other cases on bounded domain.

On the free boundary problem of the non-isentropic compressible Naiver-Stokes equations in 3D

Yuan Yuan (袁源 South China Normal University)

In this talk we will introduce the strong solutions to the free boundary problem of the full compressible Navier-Stokes equations in three-dimensional space. The vanishing density and temperature condition is imposed on the free boundary, which captures the motions of the non-isentropic viscous gas surrounded by vacuum with bounded entropy. We also assume some proper decay rates of the density towards the boundary and singularities of derivatives of the temperature across the boundary on the initial data, which coincides with the physical vacuum condition for the isentropic flows.

Euler system is approximated by turbulence model with Dirichlet boundary conditions

Aibin Zang (臧爱彬 Yichun University)

In this talk, I start to present previous some results for the convergence of α-model, which is regularized Euler equations, to Euler equations. I will show that the existence of global weak solutions for inviscid Leray-α equations and obtain the solutions of Leray-α equations converges to the solutions for Euler equations by Kato corrector as α goes to zero. This work joint with Claude Bardos and Edirss S. Titi.

Convergence to equilibrium for the solution of the full compressible Navier-Stokes equations

Ruzhao Zi (訾瑞昭 Central China Normal University)

We study the convergence to equilibrium for the full compressible Navier-Stokes equations on the torus T3. Under the conditions that both the density ρ and the temperature θ possess uniform in time positive lower and upper bounds, it is shown that global regular solutions converge to equilibrium with exponential rate. We improve the previous result obtained by Villani in [Mem. Amer. Math. Soc., 202(2009), no. 950] on two levels: weaker conditions on solutions and faster decay rates. This is a joint work with Prof. Zhifei Zhang.

5. Participants List

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