Week 1 (Sep.11-Sep.15)

Topic: Incompressible Navier-Stokes Equations

Workshop Room: Room 2201, Guanghua East Building, Fudan University

Lecture Series Speakers: Yoshikazu Giga (University of Tokyo)
Qi Zhang (University of California, Riverside)

Invited Speakers: Yuan Cai (Fudan University)
Ning Jiang (Wuhan University),
Hajime Koba (Osaka University)
Jiri Neustupa (Czech Academy of Sciences Mathematical Institute)
Yi Zhou (Fudan University)

Organizing Committee:

Peter Constantin (Princeton University)
Yoshikazu Giga (University of Tokyo)
Hao Jia (University of Chicago)
Carlos Kenig (University of Chicago)
Zhen Lei (Fudan University)
Fanghua Lin (Courant Institute of Mathematical Sciences)
Gregory Seregin (University of Oxford)
Vladimir Sverak (University of Minnesota)
Edriss Titi (Texas A & M University)
Sijue Wu (University of Michigan)

Sponsored by

Shanghai Center for Mathematical Sciences
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Schedule

2017 Fall Program on Analysis of PDE (Sept. 11 – Dec. 2, 2017)

Week 1 (Sept.11-Sept.15)	
Topic: Incompressible Navier-Stokes Equations	
Monday (September 11)	**Room 2201, Guanghua East Building, Fudan University**
Morning Session	
9:30 – 9:35	Chair： Fanghua Lin, Jun Li
9:35 – 10:25	Yoshikazu Giga
10:25 – 10:45	Tea Break
10:45 – 10:50	Chair： Yoshikazu Giga
10:50 – 11:40	Zhou Yi
Lunch Break	
Afternoon Session	
14:30 – 14:35	Chair: Yi Zhou
14:35 – 15:25	Qi Zhang
15:25 – 15:45	Tea Break
15:45 – 15:50	Chair： Qi Zhang
15:50 – 16:40	Ning Jiang
Tuesday (September 12)	**Room 2201, Guanghua East Building, Fudan University**
Morning Session	
9:30 – 9:35	Chair： Fanghua Lin
9:35 – 10:25	Yoshikazu Giga
10:25 – 10:45	Tea Break
10:45 – 10:50	Chair： Yoshikazu Giga
10:50 – 11:40	Hajime Koba
Lunch Break	

Afternoon Session	
14:30 – 14:35	Chair: Yi Zhou
14:35 – 15:25	Qi Zhang
15:25 – 15:45	Tea Break
Group Photo	**15:45 – 16:00**
16:00 – 16:05	Chair：Qi Zhang
16:05 – 16:55	Yuan Cai
Wednesday (September 13)	**Room 2201, Guanghua East Building, Fudan University**
Morning Session	
9:30 – 9:35	Chair：Fanghua Lin
9:35 – 10:25	Yoshikazu Giga
10:25 – 10:45	Tea Break
10:45 – 10:50	Chair：Yoshikazu Giga
10:50 – 11:40	Jiri Neustupa
Lunch Break	
Thursday (September 14)	**Room 2201, Guanghua East Building, Fudan University**
Morning Session	
9:30 – 9:35	Chair：Fanghua Lin
9:35 – 10:25	Yoshikazu Giga
10:25 – 10:45	Tea Break
10:45 – 10:50	Chair：-
10:50 – 11:40	Free
Lunch Break	
Afternoon Session	
14:30 – 14:35	Chair: Yoshikazu Giga -
14:35 – 15:25	Qi Zhang
15:25 – 15:45	Tea Break
15:45 – 15:50	Chair：-
15:50 – 16:40	Free

Friday (September 15) Room 2201, Guanghua East Building, Fudan University	
Morning Session	
9:30 – 9:35	Chair：Fanghua Lin
9:35 – 10:25	Qi Zhang
10:25 – 10:45	Tea Break
10:45 – 10:50	Chair：-
10:50 – 11:40	Free
Lunch Break	

2017 Fall Program on Analysis of PDE

Week 1 (Sep.11-Sep.15)

Topic: Incompressible Navier-Stokes Equations

Titles and Abstracts:

Speaker: Yoshikazu Giga

Title: On L^\infty theory for the Navier-Stokes equations and its applications to regularity criteria via vorticity direction

Abstract: It is well known that the Navier-Stokes equations is locally-in-time well-posed in various function spaces. However, it is quite recent that such problems are discussed in spaces of bounded functions when the domain has boundaries even for the Stokes equations initiated by K. Abe and the author (2013).In the series of lectures, we recall this theory and discuss its application, especially to regularity criteria via vorticity directions developed by H. Miura and the author (2011) and later by P. Hsu, Y. Maekawa and the author (2014) for a half space. The crucial step for this application consists of Liouville type theorems for spatially non-decaying functions.

Here is a short list of topics:

1. Regularity criteria based on vorticity direction

2. Liouville type theorems

3. The Navier-Stokes equations in spaces of bounded functions

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Speaker: Yuan Cai (Fudan University)

Title: Vanishing viscosity limit for incompressible viscoelasticity

Abstract: We study the inviscid limit of the two-dimensional incompressible viscoelasticity, which is a system coupling a Navier-Stokes equation with a transport equation for the deformation tensor. The existence of global smooth solutions near the equilibrium with a fixed positive viscosity was known since the work of Fanghua Lin etc. The inviscid case was solved recently by Zhen Lei. While the latter was solely based on the techniques from the studies of hyperbolic equations, and hence the 2D problem is in general more challenge than that in higher dimensions, the former was relied crucially upon a dissipative mechanism. Indeed, after a symmetrization and a linearization around the equilibrium, the system of the incompressible viscoelasticity reduces to an incompressible system of damped wave equations for both the fluid velocity and the deformation tensor. These two approaches are not compatible. In this work, we prove global existence of solutions, uniformly in both time $\t\geq 0$ and viscosity $\mu\geq 0$. This allows us to justify in particular the vanishing viscosity limit for all time. In order to overcome difficulties coming from the incompatibility between the purely hyperbolic limiting system and the systems with additional parabolic

viscous perturbations, we introduce a rather robust method which may apply to a wide class of physical systems of similar nature. Roughly speaking, the method works in two dimensional case whenever the hyperbolic system satisfies intrinsically a ``Strong Null Condition". For dimensions not less than three, the usual null condition is sufficient for this method to work.
This work is in part joint with Prof. Zhen Lei, Fanghua Lin and Nader Masmoudi.

Speaker: Ning Jiang
Title: Self-organized hydrodynamics-Navier-Stokes coupled system: well-posedness and rigorous derivation
Abstract: Recently, P. Degond and his collaborators formally derived coupled self-organized hydrodynamics Navier-Stokes system for suspensions of active particles. We proved the well-posedness of this system, and justify the limit from the kinetic-fluid model. This is a joint work with Yi-long Luo and Teng-fei Zhang.

Speaker: Hajime Koba
Title: On the Helmholtz-Weyl decomposition on surfaces and its application to fluid dynamics.
Abstract: We study the Helmholtz-Weyl decomposition of vector-valued functions on a surface. We prove that we can divide a function on the surface into the three parts such as the surface divergence-free part, the surface gradient term, and the mean curvature term. We also apply the Helmholtz-Weyl decomposition to derive incompressible fluid systems on an evolving surface. This is a joint work with Yoshikazu Giga (University of Tokyo) and Chun Liu (Penn State University).

Speaker: Jiri Neustupa
Title: A Contribution to the Theory of Regularity of a Weak Solution to the Navier-Stokes Equations via One Component of Velocity or the Negative Part of Pressure
Abstract: We deal with a suitable weak solution (**v**,p) to the Navier-Stokes equations in Omega x (0,T), where Omega is a domain in R3, T>0 and v=(v_1,v_2,v_3). We show that the regularity of (v,p) at any point (**x**, t) in Omega x (0,T) is essentially determined by the Serrin-type integrability of the positive part of a certain linear combination of v_1^2, v_2^2, v_3^2 and p in a backward neighborhood of (**x**,t). An appropriate choice of the coefficients in this linear combination leads to the Serrin-type condition on one component of **v** or, alternatively, on the negative part of p.

Speaker: Qi Zhang
Title: Ancient solutions to some parabolic equations.
Abstract: The classical Liouville theorem says that positive solutions of the Laplace equation in R^n are constants. Is it true for the heat equation in space time? The answer is no. We will survey recent results and

applications by a number of people in this direction and their extension to nonlinear equations and systems, such as Navier Stokes equations. Some open questions will be discussed.

Speaker: Yi Zhou

Title: Structure of Helicity and Global Solutions of Incompressible Navier-Stokes Equation

Abstract: We derive a new energy identity for the general three-dimensional incompressible Navier-Stokes equations by the virtue of a special structure of helicity. The new energy identity is critical with respect to its natural scaling. Moreover, it is conditionally coercive. As an application, we construct a family of finite energy smooth large solutions to the Navier-Stokes equations whose critical norms can be arbitrarily large.

Participants:

Yuan Cai (Fudan University)
Tuowei Chen (Fudan University)
Xiufang Cui (Fudan University)
Yoshikazu Giga (University of Tokyo)
Mi-Ho Giga (University of Tokyo)
Bobo Hua (Fudan University)
Ning Jiang (Wuhan University)
Zhentao Jin (Fudan University)
Hajime Koba (Osaka University)
Zhen Lei (Fudan University)
Hui Li (Peking University)
Fanghua Lin (Courant Institute)
Qing Liu (Fukuoka University)
Junren Luo (Fudan University)
Xiang Luo (University of Science and Technology of China)
Jianzhong Min (Fudan University)
Jiri Neustupa (Czech Academy of Sciences Mathematical Institute)
Yun Pu (Fudan University)
Peng Qu (Fudan University)
Jiawei Sun (Capital Normal University)
Houzhi Tang (Capital Normal University)
Chenmu Wang (Fudan University)
Yanyan Wang (Fudan University)

Hao Wu (Fudan University)
Xiaochun Wu (Fudan University)
Meng Yuan (Nanjing University)
Jing Zhang (Fudan University)
Qi Zhang (University of California, Riverside)
Qidi Zhang (Chinese Academy of Sciences)
Na Zhao (Fudan University)
Yi Zhou (Fudan University)