独立行政法人日本学術振興会 日独共同大学院プログラム
JSPS-DFG Japanese-German Graduate Externship

第７回 日独流体数学国際研究集会
The 7th Japanese-German International Workshop on Mathematical Fluid Dynamics

Nov 5 - 8, 2012 at Waseda University, Nishi-Waseda Campus

63 Bldg. 2nd Floor - 04 Conference Room

Latest version Nov. 6

■ Program ■

	Mon, Nov. 5	Tue, Nov. 6	Wed, Nov. 7	Thu, Nov. 8
9:30-10:40	Jiri NEUSTUPA ① (AS Czech Republic)	Jiri NEUSTUPA ②		
11:00-12:10	Raphael DANCHIN ① (Univ. of Paris)	Raphael DANCHIN ②	Maria LUKACOVA① (Univ. of Mainz)	Maria LUKACOVA②
12:30-13:00	Yoshihiro SHIBATA (Waseda Univ.)	Reinhard FARWIG (TU Darmstad)	Naoki TSUGE (Gifu Univ.)	Tohru NAKAMURA (Kyushu Univ.)
13:00-15:00	Lunch break			
15:00-16:10	15:00-15:30 Masashi OHNAWA (Waseda Univ.) 15:40-16:10 Matthias GEISSERT (TU Darmstadt)	Raphael DANCHIN ③	Jiri NEUSTUPA ③	Raphael DANCHIN ④
16:40-17:10	Takayuki KOBAYASHI (Saga Univ.)	Masahiro KUNIMOTO (Waseda Univ.)	Hideyuki MIURA (Osaka Univ.)	Matthias HIEBER (TU Darmstadt)
17:30-17:45	Miho MURATA (Waseda Univ.)	Noboru CHIKAMI (Tohoku Univ.)	Lorenz von BELOW (TU Darmstadt)	
17:50-18:05	Christoph ALBERT (TU Darmstadt)	Jonas SAUER (TU Darmstadt)	Hirokazu SAITO (Waseda Univ.)	＊18：00～ Reception
18:10-18:25	Bangwei SHE (Univ. of Mainz)	Manuel NESENSOHN (TU Darmstadt)		

●→Main-course ●→30min talk ●→15min talk

Discussion room → open 9:30 - 17:00 63 Bldg 1F
Meeting room for Mathematics and Applied Mathematics

Raphael DANCHIN
University of Paris VII

Title:

Fourier analysis methods, nonstandard maximal regularity and applications to fluid mechanics.

Abstract:

Since the 80's, Fourier analysis methods have known a growing interest in the study of linear and nonlinear PDE's. In particular, techniques based on Littlewood-Paley decomposition and paradifferential calculus have proved to be very efficient for solving such equations in the whole space or the torus. In this course, we aim at giving a survey of how those techniques may be used for solving systems of equations arising in fluid mechanics. We shall in particular point out the benefit that may be taken from a very simple maximal regularity estimate for heat-like equations, and will give examples of use of paralinearization techniques.

Date:

① Monday, Nov. 5 11:00-12:10 ② Tuesday, Nov. 6 11:00-12:10
③ Tuesday, Nov. 6 15:00-16:10 ④ Thursday, Nov. 8 15:00-16:10

Maria Lukacova
Johannes Gutenberg University of Mainz

Title:

Mathematical modelling and numerical simulation of fluid-structure interaction for non-Newtonian fluids.

Abstract:

Fluid-structure interaction problems appear in many areas. In the present lecture we will concentrate on specific problems arising in hemodynamics. The aim will be to study the resulting strongly nonlinear coupled system from analytical as well as numerical point of view. We address theoretical questions of well-posedness and present an efficient and robust numerical scheme in order to simulate blood flow in compliant vessels. With respect to the numerical simulations we will in particular discuss the questions of the added mass effect, stability and convergence order. We will present results of numerical simulations and demonstrate the efficiency of new kinematic splitting scheme.

Date:

① Wednesday, Nov. 7 11:00-12:10 ② Thursday, Nov. 8 11:00-12:10

Jiri NEUSTUPA
Academy of Sciences of the Czech Republic

Title:

Some recent results concerning regularity criteria for weak solutions of the Navier-Stokes equations.

Abstract:

Lecture ①: Introduction

The notion of a regular or singular point of a weak solution (respectively a suitable weak solution) to the Navier-Stokes equations. A brief survey of known criteria for regularity at the space-time point (x_0, t_0) (from Serrin, Caffarelli-Kohn-Nirenberg to newer results). Principles of proofs of some recently obtained criteria.

Date: Monday, Nov. 5 9:30-10:40

Lecture ②:

Regularity criteria based on conditions imposed only on some components of velocity or vorticity. A brief chronological survey with main ideas of the proofs. Open problems. Regularity as a result of "smoothness" of a certain spectral projection of vorticity or only one componet of the spectral projection. The role of "large frequencies".

Date: Tuesday, Nov. 6 9:30-10:40

Lecture ③:

Regularity in the neighbourhood of points on the boundary - a brief chronological survey of existing criteria. The role of boundary conditions. Principle of the proof of a criterion based on properties of the eigenvalues of the rate of deformation tensor, considering Navier's slip boundary conditions. The geometrical interpretation. Open problems.

Date: Wednesday, Nov. 7 15:00-16:10

Reinhard Farwig

Technical University of Darmstadt

with Raphael SCHULZ (TU Darmstadt)
and Masao YAMAZAKI (Waseda Univ.)

Title:

Concentration-diffusion phenomena for the Boussinesq system

Abstract:

In the whole space $\mathbb{R}^n$ we study the asymptotic behaviour of solutions (u, θ) to the Boussinesq equations with a suitable gravity field. Therefore, we investigate the solvability of these equations in weighted L^∞-spaces using semigroup techniques in homogeneous Besov spaces and determine the leading terms of an asymptotic profile for sufficiently fast decaying initial data.

Moreover, we are able to construct initial data such that the velocity exhibits an interesting concentration-diffusion phenomenon. To be more precise, let $0 =: t_0 < t_1 < \cdots < t_N < t_{N+1} := T,\ N \in \mathbb{N}$, be an arbitrary finite sequence and let the initial velocity u_0 satisfy some symmetry properties. Then there exists an initial temperature θ_0 and for each $i = 1, \ldots, N$, there are instants t_i', t_i'' arbitrarily close to t_i such that the corresponding unique strong solution (u, θ) of the Boussinesq system with initial data $(\eta u_0, \eta\theta_0)$ and $\eta > 0$ sufficiently small satisfies, for all $i = 1, \ldots, N$ and all $|x|$ large enough, (more or less) the pointwise estimate

$$|u(x, t_i')| \le c|x|^{-n+2} \quad |u(x, t_i'')| \ge c|x|^{-n}$$

References:

Farwig, R., Schulz, R., Yamazaki, M.: *Concentration-diffusion phenomena of heat convection in an incompressible fluid.* FB Mathematik, TU Darmstadt, Preprint no. 2649 (2012)

Date:

Tuesday, Nov. 6 12:30-13:00

Matthias GEISSERT

Technical University of Darmstadt

Title:

Weak Neumann implies Stokes

Abstract:

We show that the Stokes operator admits an H^∞-calculus on $L^q_\sigma(\Omega)$ provided the Helmholtz decomposition exists in $L^q(\Omega)$ and the boundary of $\Omega \subset \mathbb{R}^n$ is smooth enough.

The proof is based on properties of the Dirichlet-Laplacian, maximal regularity of the Stokes operator and an abstract result by Kalton, Kunstmann and Weis. We also discuss various approaches to maximal regularity of the Stokes operator.

Date:

Monday, Nov. 5 15:40-16:10

Matthias HIEBER
Technical University of Darmstadt

Title:

Global existence results for the Navier-Stokes equations in the rotational framework

Abstract:

Consider the equations of Navier-Stokes equations with Coriolis force, i.e.

$$\begin{aligned} u_t - \nu\Delta u + \omega e_3 \times u + u \cdot \nabla u + \nabla p &= f, \\ \operatorname{div} u &= 0, \\ u(0) &= u_0, \end{aligned}$$

on all of $\mathbb{R}^3$, where ω denotes the speed of rotation and e_3 is the unit vector in the x_3-direction. If $\omega = 0$, the classical Navier-Stokes equations have been considered by many authors in various scaling invariant spaces, in particular in

$$\dot{H}^{\frac{1}{2}}(\mathbb{R}^3) \hookrightarrow L^3(\mathbb{R}^3) \hookrightarrow B^{-1+\frac{3}{p}}_{p,\infty}(\mathbb{R}^3) \hookrightarrow BMO^{-1}(\mathbb{R}^3) \hookrightarrow B^{-1}_{\infty,\infty}(\mathbb{R}^3),$$

where $3 < p < \infty$. It is now a natural question to ask whether, for given and fixed $\omega > 0$, there exist global solutions to the above equation provided the initial data belong to some suitable function spaces. In this context, Hieber and Shibata proved a global well-posedness result for initial data being small with respect to $H^{\frac{1}{2}}(\mathbb{R}^3)$. Generalizations of this result to the case of Fourier-Besov spaces are due to Konieczny and Yoneda, and Iwabuchi and Takada. For a related approach see the work of Giga and Saal in this direction. In this talk, we continue this line of research and show that the above equations admit a unique, global solution provided the initial data are small in various Fourier-Besov spaces.

Moreover, we also investigate the two-dimensional setting and show that this case there exists a unique, global mild solution for all (*not necessarily small*) $u_0 \in L^p(\mathbb{R}^2)$ for $2 \leq p < \infty$.

Date:

Thursday, Nov. 8 16:40-17:10

Takayuki KOBAYASHI
Saga University

Title:

L^2 boundedness for the solutions to the 2D semilinear heat equations and the 2D Navier-Stokes equations

Abstract:

We consider the exterior problems for the wighted semilnear 2D heat equations, and the Cauchy problems for the 2D Navier-Stokes equations. We will show the L^2 boundedness of the solutions for the initial data in Hardy space. The results in this talk were obtained in a joint work with M. Misawa (Kumamoto University, Japan).

Date:

Monday, Nov. 5 16:40-17:10

Masahiro KUNIMOTO

Waseda University

Title:

Optimization of flow state for the control of the reduction-oxidation reaction

Abstract:

To improve efficiency of a certain chemical reaction, optimization of the flow state in the reaction system is important. This importance is outstanding in the case of chemical reaction in micro channels. We are now attempting to optimize the flow state in micro channels for reduction-oxidation reaction so that the reaction becomes favorable for nano-particle synthesis, in which the metal ion is reduced with electron provided by oxidation of reducing agents. In my presentation, I will talk about the background and strategy of this attempt. Also I will talk about the relationship between fluid dynamics and my specialized field, electrochemistry.

Date:

Tuesday, Nov. 6 16:40-17:10

Hideyuki MIURA

Osaka University

Title:

Asymptotics of small exterior Navier-Stokes flows with non-decaying boundary data

Abstract:

We prove the existence of unique solutions for the 3D incompressible Navier-Stokes equations in an exterior domain with small boundary data which do not necessarily decay in time. As a corollary, the existence of unique small time-periodic

solutions is shown. We next show that the spatial asymptotics of the periodic solution is given by the same Landau solution at all times. Lastly we show that if the boundary datum is time-periodic and the initial datum is asymptotically self-similar, then the solution converges to the sum of a time-periodic vector field and a forward self-similar vector field as time goes to infinity. This is joint work with Kyungkuen Kang and Tai-Peng Tsai.

Date:

Wednesday, Nov. 7 16:40-17:10

Tohru NAKAMURA

Kyushu University

Title:

Boundary layer solution to the symmetric hyperbolic-parabolic system

Abstract:

We consider the large-time behavior of solutions to the symmetric hyperbolic-parabolic system in the half line. We firstly prove the existence of the stationary solution (boundary layer solution) by assuming that a boundary strength is sufficiently small. Especially, in the case where one eigenvalue of Jacobian matrix appeared in a stationary problem becomes zero, we assume that the characteristics field corresponding to the zero eigenvalue is genuine non-linear in order to show the existence of a degenerate stationary solution with the aid of a center manifold theory. We next prove that the stationary solution is time asymptotically stable under a smallness assumption on the initial perturbation. The key to proof is to derive the uniform a priori estimates by using the energy method in half space developed by Matsumura and Nishida as well as the stability condition of Shizuta–Kawashima type. The present talk is based on the joint research with Professor Shinya Nishibata at Tokyo Institute of Technology.

Date:

Thursday, Nov. 8 12:30-13:00

Masashi OHNAWA

Waseda University

Title:

Asymptotic stability of boundary layers in plasma physics with fluid-boundary interaction

Abstract:

We study the asymptotic stability of a boundary layer called sheath, which appears over a material in contact with plasma. Two types of boundary conditions

on the electrostatic potential are considered depending on the physical situation. One gives a fixed potential value (DBC), while the other takes into account the effect of accumulation of charged particles on the boundary (IBC). Mathematically, we formulate the sheath by a monotone stationary solution to the Euler-Poisson system over a half space under Bohm's criterion. Reviewing our previous works on the conditions of the existence of the stationary solution, and its asymptotic stability under DBC, we present corresponding results under IBC, where we observe an interesting example of fluid-boundary interaction. This talk is based on the joint work with Prof. Shinya Nishibata and Prof. Masahiro Suzuki at Tokyo Institute of Technology.

Date:

Monday, Nov. 5 15:00-15:30

Yoshihiro SHIBATA
Waseda University

Title:

On $\mathcal{R}$-sectoriality of the Stokes equations with first order boundary condition in a general domain

Abstract:

To consider some free boundary value problem for the incompressible viscous fluid flow under the Lagrangian representation, it is a key issue to prove the $L_p - L_q$ maximal regularity for the linearlized problem. The maximal regularity is a significant aspect for the parabolic equations. In fact, the operator possessing the maximal regularity generates an analytic semigroup. But, the opposite implication does not hold in general. In this talk, I will talk about some representation formula of solutions to a generalized resolvent problem for the Stokes equations with non-homogeneous first order boundary condition in a general domain, which implies the $\mathcal{R}$-sectoriality. As a consequence, the generation of analytic semigroup and the $L_p - L_q$ maximal regularity are obtained at the same time. This is an advantage to use the $\mathcal{R}$-sectoriality compared with other methods related to the maximal regularity.

The main part of my talk is a joint work with Senjo Shimizu in Shizuoka University.

Date:

Monday, Nov. 5 12:30-13:00

Naoki TSUGE
Gifu University

Title:

Existence of Global Solutions for Unsteady Isentropic Gas Flow in a Laval Nozzle

Abstract:

We are concerned with the motion of isentropic gas in the Laval nozzle, which is a tube that is pinched in the middle, making a hourglassshape. The Laval nozzle consists of a converging entry section and a diverging exhaust section. When a gas at rest in a container or chamber under high pressure escapes through such a nozzle, two possibilities arise. The first is that the flow, a fter being expanded in the entry section, is compressed in the exhaust section and remains subsonic throughout. This occurs when the Mach number at the entry section remains below a certain critical value. However, when the Mach number attains the critical value, the alternative occurs; the flow becomes supersonic on passing the throat, where the cross section is minimum, and continues to expand from this point on. In this case, the Laval nozzle accelerates a subsonic to a supersonic flow. As a result, the gas in the exhaust section has maximal thrust. Because of this property, the nozzle is widely used in some type of turbine, which is an essential part of the modern rocket engine or the jet engine. On the other hand, the solar wind, which is the stream of the plasma ejected from the corona of the sun, becomes from subsonic to supersonic flow. This phenomenon is closely related to the flow in the Laval nozzle. In this talk, we consider unsteady flow including transonic gas. This is governed by the compressible Euler equations. In particular, we prove the existence of global solutions for the Cauchy problem. In spite of the importance, this problem has not received much attention until now. The most difficult point is to obtain the bounded estimate for approximate solutions. To overcome this, we develop the well-known Chueh, Conley and Smoller's invariant region theory. Our invariant region depends on the space variable and is closely related to the geometric structure of the nozzle. Finally, in order to prove the convergence of the approximate solutions, we use the compensated compactness framework.

Date:

Wednesday, Nov. 7 12:30-13:00

Christoph ALBERT

Technical University of Darmstadt

Title:

Linear Stability Analysis of Falling Films with Chiba's Method

Abstract:

The evolution of a thin film of a viscous fluid, running down a vertical plane under the action of gravity, is governed by the two-phase Navier-Stokes equations with a free boundary. There is a well known, trivial steady state solution, called Nusselt profile, which corresponds to a flat interface, a semi-parabolic velocity profile parallel to the wall, and a constant pressure. In applications, however, falling films are typically wavy, and the steady state solution can not be observed. We investigate the onset of waves on the surface of the film by means of Chiba's Method, which is an algorithm that can determine the asymptotic behavior of small perturbations around a steady state. With this approach, it is possible to reduce the high-dimensional stability problem to the eigenvalue problem of a matrix whose dimension is in the order of magnitude of only 100×100. So far, the method has been successfully applied to fully nonparallel, three-dimensional flow problems in aerodynamics, for example in [TS06].

In this talk, it is shown how Chiba's Method can be generalized to free boundary problems. Analyses of the stability of falling films with enforced periodicity, and with Inflow/Outflow boundary conditions are presented. The approach is validated by comparing results for the periodic case with data from the literature.

References:

[TS06] A. Tezuka, K. Suzuki, Three-dimensional global linear stability analysis of flow around a spheroid, *AIAA Journal*, **44**, (2006), 1697 - 1708.

Date:

Monday, Nov. 5 17:50-18:05

Lorenz von BELOW

Technical University of Darmstadt

Title:

On the Stokes equations with Neumann-Robin boundary conditions in an infinite layer. The resolvent problem in the case $\lambda = 0$.

Abstract:

In this talk we investigate the resolvent problem corresponding to the Stokes equations with Neumann-Robin boundary conditions in an infinite layer. We show existence and uniqueness of solutions in an L_p-framework for λ sufficiently close to 0.

Date:

Wednesday, Nov. 7 17:30-17:45

Noboru CHIKAMI

Tohoku University

Title:

The local existence and blow-up criterion for the compressible Navier-Stokes system with a Yukawa-potential in Besov spaces

Abstract:

We consider the Cauchy problem of the compressible Navier-Stokes system with a Yukawa-potential in $\mathbb{R}^N$ ($N \geq 2$), which is a simplified hydrodynamical model describing the nuclear matter. We prove the local existence and uniqueness of the solution of the compressible Navier-Stokes-Yukawa system in the critical Besov spaces. Our second result concerns a refined blow-up criterion for the solution of the system. Specifically, we show that the $\dot{B}^0_{\infty,\infty}$ control of ∇u is sufficient for the continuation of the solution beyond its existence time.

Date:

Tuesday, Nov. 6 17:30-17:45

Miho MURATA

Waseda University

Title:

On the sectorial $\mathcal{R}$-boundedness of the Stokes operator for the compressible viscous fluid flow in a general domain

Abstract:

We consider the linear problem describing motion of the compressible viscous fluid flow in a general domain with slip boundary condition. The general domain is uniform $W^{3-1/r}_r$ domain and slip boundary condition is consist of first order derivative term and non-homogeneous data. In this talk, we prove the generation of analytic semigroup and the maximal L_p-L_q regularity in order to obtain local in time unique existence theorem of solutions to the corresponding linear problem. The key of the proof of the generation of analytic semigroup and the maximal L_p-L_q regularity is to prove the $\mathcal{R}$-boundedness for the Stokes equations with non-homogeneous boundary conditions.

Date:

Monday, Nov. 5 17:30-17:45

Manuel NESENSOHN

Technical University of Darmstadt

Title:

On global L_p-solutions for some Oldroyd models on bounded domains

Abstract:

Classical models to describe viscoelastic fluids are those of the Oldroyd type. For these models, a result on existence and uniqueness of global L_p-solution on bounded domains with arbitrarily large coupling constants is presented. For the proof, the system is formulated in Lagrangian coordinates. The key of the analysis is to show maximal regularity of the associated linearization. The full nonlinear problem is solved by the application of the contraction mapping principle.

Date:

Tuesday, Nov. 6 18:10-18:25

Hirokazu SAITO

Waseda University

Title:

On the L_p-L_q maximal regularity for the Stokes problem with the Neumann-Robin boundary condition in an infinite layer

Abstract:

In this talk, I would like to consider the L_p-L_q maximal regularity of the Stokes problem with the Neumann-Robin-type boundary condition in an infinite layer. This Stokes problem appears in the linearized problem of the spin-coating process, which is treated in [1]. The spin-coating process is a free boundary problem, so that the equations turns to quasilinear when we transform the domain to a fixed domain. Therefore, we need the maximal regularity in order to deal with the equations. From viewpoint of this, we consider the L_p-L_q maximal regularity of this Stokes problem.

References:

[1] R. Denk, M. Geissert, M. Hieber, J. Saal and O. Sawada, *The spin-coating process: analysis of the free boundary value problem*, Comm. Partial Differential Equations **36** (2011), no. 7, 1145-1192.

Date:

Wednesday, Nov. 7 17:50-18:05

Jonas SAUER

Technical University of Darmstadt

Title:

Very weak solutions of the stationary Stokes equations in unbounded domains of half space type

Abstract:

The talk will concern the theory of very weak solutions of the stationary Stokes system with nonhomogeneous boundary data and divergence in domains of half space type, such as $\mathbb{R}^n_+$, bent half spaces the boundary of which can be written as the graph of a Lipschitz function, perturbed half spaces as local, but possibly large perturbations of $\mathbb{R}^n_+$, and in aperture domains. The proofs are based on duality arguments and corresponding results for strong solutions in these domains which have to be constructed in homogeneous Sobolev spaces.

Date:

Tuesday, Nov. 6 17:50-18:05

Bangwei SHE

Johannes Gutenberg University of Mainz

Title:

On some numerical tests of viscoelastic flows

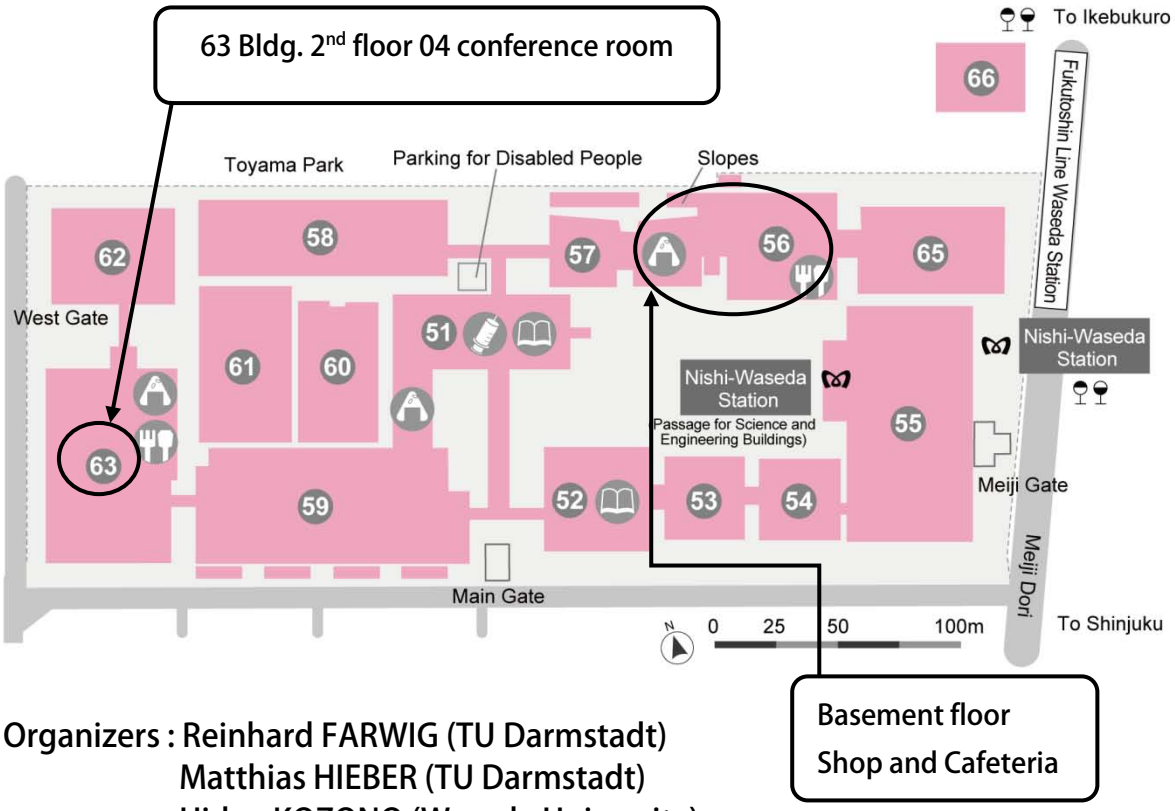
Abstract:

We present a combined finite difference and finite volume scheme for viscoelastic flows. The high Weissenberg number problem is overcome by using log-conformation representation. However, the convergence is still an open problem.

Date:

Monday, Nov. 5 18:10-18:25

Campus Map



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- JSPS Grant No.24224004, Construction of to investigate the fluid structure
  from the macroscopic view point and the mesoscopic view point (Yoshihiro SHIBATA)