Last update: December 26, 2017

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 15 回 日独流体数学国際研究集会
The 15th Japanese-German International Workshop on Mathematical Fluid Dynamics

January 9 - 12, 2018 at Waseda University, Nishi-Waseda Campus
55N Bldg. 1st Floor Conference Room

■ Program ■

Tue, Jan. 9	Wed, Jan. 10	Thu, Jan. 11	Fri, Jan. 12
10:50~ Opening	9:30-10:40 **Yoshihiro SHIBATA①** (Waseda Univ.)	9:30-10:40 **Fanghua LIN③**	9:30-10:40 **Yoshihiro SHIBATA③**
11:00-12:10 **Fanghua LIN①** (New York Univ.)	10:55-12:05 **Fanghua LIN②**	10:55-12:05 **Yoshihiro SHIBATA②**	10:55-11:25 **Amru HUSSEIN** (TU Darmstadt) 11:35-12:05 **Takahito KASHIWABARA** (Univ. of Tokyo)
12:20-12:50 **Theodore D. DRIVAS** (Princeton Univ.)	12:15-12:45 **Dieter BOTHE** (TU Darmstadt)	12:15-12:45 **Reinhard FARWIG** (TU Darmstadt)	12:15-12:45 **Okihiro SAWADA** (Gifu Univ.)
Lunch Break			
14:30-15:00 **Ryo TAKADA** (Kyushu Univ.)	14:30-15:00 **Masahiro KUNIMOTO** (Waseda Univ.)	14:30-15:00 **Thieu Huy NGUYEN** (Hanoi Univ. of Sci. and Tech.)	14:30-15:00 **Patrick TOLKSDORF** (TU Darmstadt)
15:10-15:40 **Kohei SOGA** (Keio Univ.)	15:10-15:40 **Shinya UCHIUMI** (Waseda Unv.)	15:10-15:40 **Takahiro OKABE** (Hirosaki Uni.)	15:10-15:40 **Tsukasa IWABUCHI** (Tohoku Uni.)
Coffee Break			
16:15-16:45 **Hajime KOBA** (Osaka Univ.)	16:15-16:45 **Hirokazu SAITO** (Waseda Univ.)	16:15-16:45 **Ken ABE** (Osaka City Univ.)	16:15-16:55 **Marc WRONA** (TU Darmstadt) **Mitsuo HIGAKI** (Kyoto Univ.) **Hana MIZEROVA** (Czech Acad. Sci.) **Sebastian ZAIGLER** (TU Darmstadt)
16:55-17:25 **Kazuyuki TSUDA** (Osaka Univ.)	16:55-17:25 **Miho MURATA** (Kanagawa Univ.)	16:55-17:25 **Erika USHIKOSHI** (Yokohama National Univ.)	
17:35-18:15 **Keiichi WATANABE** (Waseda Univ.) **Naoto KAJIWARA** (Univ. of Tokyo) **Klaus KRESS** (TU Darmstadt) **Mathis GRIES** (TU Darmstadt)	17:35-18:15 **Suma'inna** (Waseda Univ.) **Ken FURUKAWA** (Univ. of Tokyo) **Anton SEYFERT** (TU Darmstadt) **Yuka TERAMOTO** (Kyushu Univ.)	17:35-18:15 **Kohei NAKAO** (Shinshu Univ.) **Hiroyuki TSURUMI** (Waseda Univ.) **David WEGMANN** (TU Darmstadt) **Andreas SCHMIDT** (TU Darmstadt)	17:00 Closing 17:30~ Closing Reception

●→Main-course ●→30min talk ●→10min talk

Main-Course

Fanghua LIN

New York University, New York

Title:

Existence and Regularity Theory of Suitable Weak Solutions of the Incompressible Navier-Stokes equations.

Abstract:

After a brief discussion on the classical Leray-Hopf weak solutions, the energy equality and inequality, we shall concentrate mainly on the existence and regularity(partial regularity) of suitable weak solutions. The notion of suitable weak solutions were introduced in the works of Sheaffer, Caffarelli-Kohn-Nirenberg. The latter also established its existence. Here I shall present some other constructions of suitable weak solutions. We then discuss the regularity of these suitable weak solutions and to see how they connected to the earlier contributions of Serrin, Prodi, and others and recent works by Seregin, Sverak and others.

Date:

① Tuesday, Jan. 09 11:00-12:10 ② Wednesday, Jan. 10 10:55-12:05
③ Thursday, Jan. 11 09:30-10:40

Yoshihiro SHIBATA

Waseda University, Tokyo

Title:

Maximal regularity and free boundary problem for the Navier-Stokes equations

Abstract:

I will give the following talks.

1st lecture: L_p-L_q maximal regularity for the Stokes equations with free boundary conditions and the local well-posedness for some free boundary problem of the Navier-Stokes equations.

2nd lecture: The global well-posedness for free boundary problem of the Navier-Stokes equations with surface tension in the case that the reference domain is closed to a ball and initial data are small enough.

3rd lecture: The global well-posedness for free boundary problem of the Navier-Stokes equations without surface tension in the case that the reference domain is an exterior domain and initial data are small enough.

Date:

① Wednesday, Jan. 10 09:30-10:40 ② Thursday, Jan. 11 10:55-12:05
③ Friday, Jan. 12 09:30-10:40

30 minutes talks

Ken ABE

Osaka City University

Title:

Axisymmetric flows in an exterior domain

Abstract:

We consider the three-dimensional Navier-Stokes equations for axisymmetric initial data

$$u_0(x) = u_0^r(r,z)e_r(\theta) + u_0^\theta(r,z)e_\theta(\theta) + u_0^z(r,z)e_z.$$

Here (r,θ,z) denotes the cylindrical coordinate and e_r, e_θ, e_z are the basis in $\mathbb{R}^3$. The azimuthal component of velocity u^θ is referred as the swirl component. It is known that the Cauchy problem of the Navier-Stokes equations is globally well-posed for large axisymmetric initial data in L^3 with finite energy, if the swirl component of initial velocity is identically zero (with no swirl). For initial data with swirl, unique solvability of the Cauchy problem in $L^3 \cap L^2$ is unknown.

In this talk, we study axisymmetric flows with swirl in an exterior domain

$$\Pi = \{(x_1,x_2,x_3) \in \mathbb{R}^3 \mid x_h = (x_1,x_2),\ |x_h| > 1\},$$

subject to the slip boundary condition $(D(u)n)_{\tan} = 0$, $u \cdot n = 0$ on $\partial\Pi$, where $D(u) = (\nabla u + \nabla^T u)/2$ is the deformation tensor, n is the unit normal and $f_{\tan} = f - n(f \cdot n)$ denotes the tangential component of a vector field f on $\partial\Pi$. We report unique existence of global solutions for large axisymmetric data in $L^3 \cap L^2$ satisfying the decay condition of the swirl component $|x_h|u_0^\theta \in L^\infty$. This talk is based on a joint work with Prof. Seregin (St. Petersburg/ Oxford).

Date:

Thursday, Jan. 11 16:15-16:45

Dieter BOTHE

Technical University of Darmstadt

Title:

Thermodynamically consistent modeling of multicomponent diffusion

Abstract:

We revisit the modelling of multicomponent diffusion within the framework of

thermodynamics of irreversible processes with main emphasis on class-I models which comprise partial mass balances for all chemical constituents, but a common momentum and energy balance. Consistency of the mass fluxes with the continuity equation requires the fluxes to sum up to zero. Within the standard approach one flux is eliminated, leading to the generalized Fickean multicomponent diffusion fluxes. This procedure breaks the symmetry between the different species and therefore requires a non-diagonal, fully coupled closure. The (cross-)mobilities necessarily depend on the composition in a complicated, singular manner. In particular, constant mobilities are inconsistent with the physically required forward invariance of the cone of non-negative partial densities.

Alternatively, the Maxwell-Stefan theory also fits within the same framework, but uses a so-called resistance form in which the closure is performed for the diffusion velocities. In contrast to the Fickean closure, the resulting fluxes are consistent to non-negativity of the partial densities even if constant Maxwell-Stefan diffusivities are employed. But, similar as for the Fickean approach, the closure requires a fully occupied matrix of MS-diffusivities. From experiments as well as from molecular dynamics simulations it is known that MS-diffusivities are not constant but depend especially on the mixture composition, although in a non-singular manner. A theoretical model for this dependence was recently proposed as a multicomponent extension of the Darken equation known from diffusion in solids.

After reviewing these two known diffusion theories, we propose and discuss a novel and more direct closure which avoids the tedious inversion of the Maxwell-Stefan equations. More importantly, it also gives rise to a diagonal closure in which only those cross-effects are present that are necessary to guarantee consistency with total mass conservation plus a compositional dependence of the diffusivity. We show that the latter case corresponds precisely to the multicomponent Darken equation.

Date:

Wednesday, Jan. 10 12:15-12:45

Theodore D. DRIVAS

Princeton University tdrivas@math.princeton.edu

Title:

An Onsager Singularity Theorem for the Compressible Euler Equations

Abstract:

We prove that bounded weak solutions of the compressible Euler equations will conserve thermodynamic entropy, unless the solution fields have sufficiently low space-time Besov regularity. A quantity measuring kinetic energy cascade will also vanish for such Euler solutions, unless the same singularity conditions are satisfied. It is shown furthermore that strong limits of solutions of compressible

Navier-Stokes equations that are bounded and exhibit anomalous dissipation are weak Euler solutions. These inviscid limit solutions have non-negative anomalous entropy production and kinetic energy dissipation, with both vanishing when solutions are above the critical degree of Besov regularity. Stationary, planar shocks in Euclidean space with an ideal-gas equation of state provide simple examples that satisfy the conditions of our theorems and which demonstrate sharpness of our L^3-based conditions. This talk is based on joint work with G. Eyink.

Date:

Tuesday, Jan. 09 12:20-12:50

Reinhard FARWIG

Technical University of Darmstadt

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Chenyin Qian

Department of Mathematics, Zhejiang Normal University, China

Title:

The global attractor for autonomous quasi-geostrophic equations with fractional dissipation in $\mathbb{R}^2$

Abstract:

Consider the autonomous quasi-geostrophic equation with fractional dissipation in $\mathbb{R}^2$

$$\theta_t + u \cdot \nabla\theta + (-\Delta)^\alpha \theta = f(x, \theta)$$

in the subcritical case $1/2 < \alpha \leq 1$, with initial condition $\theta(x, 0) = \theta^0$ and given external force $f(x, \theta)$. Here the real scalar function θ is the so-called potential temperature, and the incompressible velocity field $u = (u_1, u_2) = (-\mathcal{R}_2\theta, \mathcal{R}_1\theta)$ is determined from θ via Riesz operators. Our aim is to prove the existence of the compact global attractor $\mathcal{A}$ in the Bessel potential space $H^s(\mathbb{R}^2)$ when $s > 2(1-\alpha)$.

The construction of the attractor is based on the existence of an absorbing set in $L^2(\mathbb{R}^2)$ and $H^s(\mathbb{R}^2)$ where $s > 2(1-\alpha)$. A second major step is usually based on compact Sobolev embeddings which unfortunately do not hold for unbounded domains. To circumvent this problem we exploit compact Sobolev embeddings on balls $B_R \subset \mathbb{R}^2$ and uniform smallness estimates of solutions on $\mathbb{R}^2 \setminus B_R$. In the literature the latter estimates are obtained by a damping term $\lambda\theta$, $\lambda < 0$, as part of the right hand side f to guarantee exponential decay estimates. In our approach we exploit a much weaker nonlocal damping term of convolution type $\rho * \theta$ with negative Fourier transform $\widehat{\rho}$.

Date:

Thursday, Jan. 11 12:15-12:45

Amru HUSSEIN

Technical University of Darmstadt

Title:

Nematic Liquid Crystals in Lipschitz domains

Abstract:

Liquid crystals are materials which behave with some respects like a liquid and with others like a solid crystal, and they have become present in everyday life by their practical application in liquid crystal displays (LCD).

The Ericksen-Leslie theory is a continuum theory for liquid crystals coupling a fluid equation to an equation for the director field which describes the orientation of the rod-like crystals.

We consider the simplified Ericksen-Leslie model in three dimensional bounded Lipschitz domains. Applying a semilinear approach, we prove local and global well-posedness (assuming a smallness condition on the initial data) in critical spaces for initial data in L^3_σ for the fluid and $W^{1,3}$ for the director field. The analysis of such models, so far, has been restricted to domains with smooth boundaries, and well-posedness in critical spaces has not been proven for bounded domains.

This talk is based on a joint work with Anupam Pal Choudhury and Patrick Tolksdorf.

Date:

Friday, Jan. 12 10:55-11:25

Tsukasa IWABUCHI

Tohoku University

Title:

Ill-posedness for the compressible Navier-Stokes equations under the barotropic condition

Abstract:

We consider the compressilbe Navier-Stokes system in the critical Besov spaces. It is known that the system is (semi-)well-posed in the scaling semi-invariant spaces of the homogeneous Besov spaces $\dot{B}^{\frac{n}{p}}_{p,1} \times \dot{B}^{\frac{n}{p}-1}_{p,1}$ for all $1 \leq p < 2n$. On the other hand if the data is in a larger scaling invariant class such as $p > 2n$, then the system is not well-posed. In this talk, we show that for the critical case $p = 2n$ the system is ill-posed by showing that there exists an explicit example of initial data such that the corresponding strong solution is strongly discontinuous as $t \to 0$.

Date:

Friday, Jan. 12 15:10-15:40

Takahito KASHIWABARA

The University of Tokyo

Title:

Global strong well-posedness of the primitive equations in $L^\infty_{xy}L^p_z$-type spaces

Abstract:

Primitive equations, which describe large scale motion of ocean or atmosphere, are obtained by assuming the hydrostatic balance in the vertical direction of the 3D Navier-Stokes equations. In our previous results, existence and uniqueness of a global-in-time strong solution to the primitive equations within the L^p-framework have been established either by analytic semigroup approach or by maximal regularity. In this talk, we will discuss cases corresponding to the end-point case $p = \infty$. More precisely, the Banach space which our analysis is based on is L^∞ in the horizontal variables x, y and L^p in the vertical one z. We prove that one can construct via the Fujita-Kato method a unique strong solution for the initial data in $C_{xy}L^p_z$, where arbitrary perturbation in $L^\infty_{xy}L^p_z$ is allowed provided it is small. The proofs are quite different depending on boundary conditions (Dirichlet or Neumann).

Date:

Friday, Jan. 12 11:35-12:05

Hajime KOBA

Osaka University

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Title:

On the Helmholtz-Weyl decomposition on surfaces and its application to multiphase flow

Abstract:

We study the Helmholtz-Weyl decomposition of vector-valued functions on a surface. We prove that we can decompose an L^2-vector field on the surface into the three parts such as a surface divergence-free part, surface gradient part, and a mean curvature part. We also apply the Helmholtz-Weyl decomposition to consider a mathematical modeling of multiphase flow with surface tension.

A part of this talk is based on joint researches with Yoshikazu Giga (University of Tokyo), Chun Liu (Illinois Institute of Technology, Chicago), and Kazuki Sato (Osaka University).

References:

[1] H. Koba, C. Liu, and Y.Giga, *Errata to Energetic variational approaches for incompressible fluid systems on an evolving surface*. to appear in Quart. Appl. Math.

[2] H. Koba and K. Sato, *Energetic variational approaches for non-Newtonian fluid systems*. preprint, arXiv:1705.06956.

Date:

Tuesday, Jan. 09 16:15-16:45

Masahiro KUNIMOTO

Waseda University

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Title:

Modeling and Spectroscopic Analysis of the Liquid-liquid Extraction of Boric Acid in Micro Channel Devices

Abstract:

For the mechanistic understanding of chemical reactions at the liquid-liquid interface of aqueous and organic phases, theoretical modeling and analysis are conducted for the interfacial reaction taking place in a Y-shaped micro flow channel. As a target reaction, a condensation of boric acid (aqueous side) with 2,2,4-trimethyl-1, 3-pentanediol (organic side), as "TMPD", is chosen, which serves as one of the extraction processes to eliminate boron impurities from the aqueous solution. TMPD is one of the hydrophobic diol compounds. It is worth noting that boric acid and TMPD are expected to react at the liquid-liquid interfacial area to produce hydrophobic species to be transferred to the organic phase, which results in the removal of boron from the aqueous phase. The modeling strategy is as follows. Regarding the flow inside, the typical parabolic profile describing laminar flow that is common in the case of micro channel systems is employed, based on the following assumptions: (i) the flow is incompressible, (ii) the gravity effect is sufficiently small to be neglected, (iii) there is no surface tension at the liquid-liquid interface, and (iv) the flow regime inside the channel is a well-developed. Regarding the reaction rate of the condensation, the rate constant of the second-order reaction is estimated from the activation free energy obtained from quantum chemical calculations. The flow profile and rate constants above are put into the equation governing the mass balance of all chemical components in the system, to be solved under the boundary condition that the reaction takes place not in the bulk area but only at the interface. In the presentation, the simulation using this modeling will be demonstrated, compared to the experimental results from spectroscopic measurements. Moreover, the molecular level mechanism of the reaction of boric acid and TMPD, which is proposed by the series of modeling studies, will be also described.

Date:

Wednesday, Jan. 10 14:30-15:00

Miho MURATA
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Yoshihiro SHIBATA
Waseda University

Title:

Decay estimates of solutions for the Navier-Stokes-Korteweg system in $\mathbb{R}^N$

Abstract:

In this talk, we consider the Navier-Stokes-Korteweg system in $\mathbb{R}^N$:

$$\begin{cases} \partial_t \rho + \operatorname{div}(\rho \mathbf{u}) = 0 & \text{in } \mathbb{R}^N,\ t \in (0,T), \\ \rho\,(\partial_t \mathbf{u} + \mathbf{u}\cdot\nabla\mathbf{u}) - \operatorname{Div}(\mathbf{S}+\mathbf{K}) + \nabla P(\rho) = 0 & \text{in } \mathbb{R}^N,\ t \in (0,T), \\ (\rho, \mathbf{u})|_{t=0} = (\rho_* + \rho_0, \mathbf{u}_0) & \text{in } \mathbb{R}^N. \end{cases}$$

Here ρ, $\mathbf{u}$ and P denote the density, velocity and pressure of fluid, respectively. The viscous stress tensor $\mathbf{S}$ and the Korteweg stress tensor $\mathbf{K}$ are $\mathbf{S} = 2\mu\mathbf{D}(\mathbf{u}) + (\nu-\mu)\operatorname{div}\mathbf{u}\mathbf{I}$, and $\mathbf{K} = (\kappa\rho\Delta\rho + \kappa/2|\nabla\rho|^2)\mathbf{I} - \kappa\nabla\rho\otimes\nabla\rho$ with $\mathbf{I}$ the $N\times N$ identity matrix and $\mathbf{D}(\mathbf{u}) = \{\nabla\mathbf{u} + (\nabla\mathbf{u})^T\}/2$, μ, ν are viscosity coefficients, and κ is a capillary coefficient. ρ_* is a positive constant. This system was first introduce by Korteweg D. J.[1].

It is shown that the system admits a unique, global strong solution for small initial data in the L_p in time and L_q in space setting. For the purpose, the main tools are the maximal L_p-L_q regularities and L_p-L_q decay properties to the linearized equations. This talk is based on a joint work with Professor Yoshihiro Shibata in Waseda University.

References:

[1] Korteweg D. J., "Sur la forme que prennent les équations du mouvement des fluides si l'on tient compte des force capillaires causées par des variations de densité considérables mais continues et sur la théorie de la capillarite dans l'hypothèse d'une variation continue de la densité," Archives Néelandaises des sciences exactes et naturelles, Ser **2**, (6), 1–24 (1901).

Date:

Wednesday, Jan. 10 16:55-17:25

Thieu Huy NGUYEN

Hanoi University of Science and Technology

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Title:

Asymptotic Behavior of Certain Navier-Stokes Flows on Unbounded Domains

Abstract:

In this talk, we will present some our recent results published in [1, 2, 3] on boundedness, periodicity and stability of solutions to fluid flow problems in unbounded domains. We start from a general framework of evolution equations on an unbounded domain Ω, namely, we consider the general semi-linear equations on Ω of the form

$$\begin{cases} u_t + Au = \mathbb{P}\mathrm{div}(G(u) + F(t)) \\ \quad u(0) = u_0, \end{cases} \tag{1}$$

where $-A$ generates a C_0-semigroup $(e^{-tA})_{t\geq 0}$ on $L^d_{\sigma,w}(\Omega)$, $\mathbb{P}$ is Helmholtz projection; G is a nonlinear and local Lipschitz operator acting from $L^d_{\sigma,w}(\Omega)$ into $L^{d/2}_{\sigma,w}(\Omega)^{d^2}$, and $F(\cdot)$ is a time-dependent second-order tensor in $L^{d/2}_{\sigma,w}(\Omega)^{d^2}$. Under relevant assumptions on $L^p - L^q$ smoothing properties of $(e^{-tA})_{t\geq 0}$ and local Lipschitz properties of G, and using the interpolation functors combined with differential inequalities and fixed point arguments we are able to prove the existence of bounded (in time t) solutions to (1) for each bounded tensor $F(\cdot)$. Then, we can use either an ergodic approach in concrete cases (see [2]) or topology arguments in the general case (see [1]) to prove the existence of periodic solutions to fluid flow problems. Moreover, our methods can be extended to obtain the stability of such bounded and/or periodic solutions to such problem (see [3]). Our abstract results can be applied to certain Navier-Stokes flows such as Navier-Stokes-Oseen flow, the Navier-Stokes flow past rotating obstacles, and, in the geophysical setting etc.

References:

[1] M. Geissert, M. Hieber, Thieu Huy Nguyen, *A General Approach to Time Periodic Incompressible Viscous Fluid Flow Problems*, Archive for Rational Mechanics and Analysis 220 (2016), 1095–1118.

[2] T.H. Nguyen, *Periodic motions of Stokes and Navier-Stokes flows around a rotating obstacle*, *Arch. Ration. Mech. Anal.*, **213** (2014), 689–703.

[3] T.H. Nguyen, T.N.H. Vu, T.X. Pham, *Boundedness and stability of solutions to semi-linear equations and applications to fluid dynamics,* Communications on Pure and Applied Analysis 15 (2016), 2103–2116.

Date:

Thursday, Jan. 11 14:30-15:00

Takahiro OKABE

Hirosaki University

Title:

Remark on the strong solvability of the Navier-Stokes equations in the weak L^n space

Abstract:

We consider the Cauchy problem of the Navier-Stokes equations in weak Lebesgue space $L^{n,\infty}(\mathbb{R}^n)$, $n \geq 3$ with non-trivial forces f. The aim of this talk is that we construct a strong solution of (N-S) in the framework of $L^{n,\infty}$, i.e., the solution which satisfies the orbit $u(t)$ lies in $L^{n,\infty}(\mathbb{R}^n)$ and satisfies

$$\frac{d}{dt}u - \Delta u + \mathbb{P}[u \cdot \nabla u] = \mathbb{P}f \quad \text{in } L^{n,\infty}(\mathbb{R}^n), \qquad t > 0. \tag{DE}$$

Borchers-Miyakawa [2] construct such a solution with $f \equiv f(x)$ as a perturbed equation from the stationary solution for f. However, for non-trivial forces $f = f(x,t)$, we need some qualitative condition for f in order to verify (DE). So introducing the subspace where the Stokes semigroup is strongly continuous we observe that the mild solution of (N-S) becomes a strong solution, i.e., satisfies (DE) when f in the subspace.

Moreover, by virtue of the subspace, we establish the local well-posedness within weak mild solutions of (N-S) under $f \in BC([0,T); \widetilde{L}^{\frac{n}{3},\infty}(\mathbb{R}^n))$, $n \geq 4$ and $f \in BC([0,T); L^1(\mathbb{R}^3))$, where $\widetilde{L}^{p,\infty}(\mathbb{R}^n) = \overline{\{f \in L^{p,\infty}(\mathbb{R}^n); f \in L^\infty(\mathbb{R}^n)\}}^{\|\cdot\|_{p,\infty}}$. By controlling the singularity of initial data and f, we obtain not only (small) global solutions, but also a unique (large) local solutions of (N-S). Especially for the uniqueness criterion for a general data, we find Brezis' argument [1] can be applicable. Therefore, we see that if the initial data has a bad singularity in $L^{n,\infty}(\mathbb{R}^n)$ then the mild solution in the class $BC([0,T); L^{n,\infty}(\mathbb{R}^n))$ never stays in $C((0,T); L^r(\mathbb{R}^n))$ with some $r > n$.

This is a joint work with Professor Yohei Tsutsui.

References:

[1] H. Brezis, Arch. Rational Mech. Anal., **128** (1994), 359–360.

[2] W. Borchers and T. Miyakawa, Acta Math., **174** (1995), 311–382.

[3] H. Kozono and M. Yamazaki, Math. Z., **228** (1998), 751–785.

Date:

Thursday, Jan. 11 15:10-15:40

Hirokazu SAITO

Waseda University

Title:

Maximal regularity for the Navier-Stokes-Korteweg system and its application

Abstract:

In this talk, we would like to consider the Navier-Stokes-Korteweg system on domains of $\mathbf{R}^N$, $N \geq 2$. Korteweg introduced in the early 1900s a stress tensor including the density gradient $\nabla\rho$ in order to model fluid capillarity effects. After that, Dunn and Serrin [1] derived rigorously

$$\mathbf{K}(\rho) = \frac{\kappa}{2}(\Delta\rho^2 - |\nabla\rho|^2)\mathbf{I} - \kappa\nabla\rho \otimes \nabla\rho$$

that is called a Korteweg tensor nowadays, where $\kappa > 0$ is a capillary coefficient. In this approach, the momentum equation is turned into

$$\rho(\partial_t\mathbf{u} + \mathbf{u}\cdot\nabla\mathbf{u}) = \mathrm{Div}(\mathbf{S}(\mathbf{u}) + \mathbf{K}(\rho) - P(\rho)\mathbf{I}),$$

with the standard viscous stress $\mathbf{S}(\mathbf{u}) = \mu\mathbf{D}(\mathbf{u}) + (\nu - \mu)\mathrm{div}\mathbf{u}\mathbf{I}$ and the pressure $P(\rho)$, which is called the Navier-Stokes-Korteweg equation. We discuss in this talk the maximal regularity for the linearized system and its application to the local solvability of the Navier-Stokes-Korteweg system with non-slip boundary condition. Our result of the local solvability especially relaxes the regularity of solutions for the previous work due to Kotschote [2].

References:

[1] J. E. Dunn and J. Serrin. On the thermomechanics of interstitial working. *Arch. Rational Mech. Anal.*, 88(2):95–133, 1985.

[2] M. Kotschote. Strong solutions for a compressible fluid model of Korteweg type. *Ann. Inst. H. Poincaré Anal. Non Linéaire*, 25(4):679–696, 2008.

Date:

Wednesday, Jan. 10 16:15-16:45

Okihiro SAWADA

Gifu University

Yanagido 1-1, Applied Physics Course, Gifu University, Gifu City, 501-1193, Japan.

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Title:

On the time-local solvability of the primitive equations with linearly growing initial data

Abstract:

The primitive equations in an infinity layer domain are considered:

$$\text{(P)} \quad \begin{cases} \partial_t \vec{U}_H - \Delta \vec{U}_H + \vec{U} \cdot \vec{\nabla} \vec{U}_H + \vec{\nabla}_H P &= 0 \quad \text{in } \Omega \times (0,T), \\ \partial_3 P &= 0 \quad \text{in } \Omega \times (0,T), \\ \vec{\nabla} \cdot \vec{U} &= 0 \quad \text{in } \Omega \times (0,T), \\ \vec{U}_H|_{t=0} &= \vec{U}_{H,0} \quad \text{in } \Omega. \end{cases}$$

Here $\vec{U} = (\vec{U}_H, U_3) = (U_1, U_2, U_3)$ denotes the velocity, and P is the pressure at $t \in (0,T)$ and $\vec{x} = (\vec{x}_H, x_3) = (x_1, x_2, x_3) \in \Omega = \mathbb{R}^2 \times (-h, h)$ with $h > 0$; $\partial_i = \partial/\partial x_i$, $\vec{\nabla} = (\vec{\nabla}_H, \partial_3) = (\partial_1, \partial_2, \partial_3)$ and $\Delta = \partial_1^2 + \partial_2^2 + \partial_3^2$. We impose that $U_3 = 0$ and some conditions for $\vec{U}_H$ on the boundary $\partial\Omega = \Gamma$, and some compatibility conditions for the initial data $\vec{U}_{H,0}$. The horizontal velocity $\vec{U}_H$ is mainly discussed, since we see

$$U_3(x_1, x_2, x_3, t) = -\int_{-h}^{x_3} \vec{\nabla}_H \cdot \vec{U}_H(x_1, x_2, \zeta, t) d\zeta.$$

Let $M \in \mathbb{R}^{2\times 2}$ with $\operatorname{tr} M = 0$, and let $\vec{U}_{H,0}(\vec{x}) = -M\vec{x}_H + \vec{u}_0(\vec{x})$. So, $\vec{u} := (u_1, u_2) := \vec{U}_H + M\vec{x}_H$ might satisfy the intgral equation

$$\vec{u}(t) = e^{t\mathcal{L}} \vec{u}_0 - \int_0^t e^{(t-s)\mathcal{L}}\, \mathbb{P}\big\{\vec{u} \cdot \vec{\nabla}_H \vec{u} + U_3 \partial_3 \vec{u} - 2M\vec{u}\big\}(s) ds$$

with some $\vec{u}_0$ in certain Sobolev spaces associated with

$$L^p_\sigma(\Omega) := \overline{\big\{\vec{\varphi} \in C^\infty(\Omega)^2 : \vec{\nabla}_H \cdot \overline{\vec{\varphi}} = 0\big\}}^{\|\cdot\|_{L^p(\Omega)}}$$

for $p \in (1, \infty)$, via the Ornstein-Uhlenbeck type semigroup $\{e^{t\mathcal{L}}\}_{t\geq 0}$ generated by

$$\begin{aligned} \mathcal{L}\vec{\varphi} &:= \Delta\vec{\varphi} + M\vec{x}_H \cdot \vec{\nabla}_H \vec{\varphi} - M\vec{\varphi} - (\mathbb{I} - \mathbb{P})\operatorname{tr}_D \partial_3 \vec{\varphi}, \\ D(\mathcal{L}) &:= \big\{\vec{\varphi} \in H^{2,p}(\Omega)^2 : \partial_3 \vec{\varphi}|_{\Gamma_N} = 0 \text{ and } \vec{\varphi}|_{\Gamma_D} = 0,\, M\vec{x}_H \cdot \vec{\nabla}_H \vec{\varphi} \in L^p(\Omega)^2\big\}. \end{aligned}$$

Here, $\mathbb{P}$ is the projection from $L^p(\Omega)$ to $L^p_\sigma(\Omega)$, and $\overline{\vec{\varphi}}(x_1, x_2) := \dfrac{1}{2h}\displaystyle\int_{-h}^{h} \vec{\varphi}(x_1, x_2, \zeta) d\zeta$.

To obtain smoothing properties of the semigroup, derivatives of the associated kernel are calculated. To establish the time-local existence and uniqueness of mild solutions (solutions to the integral equation), the adapted Fujita-Kato scheme is used.

This is a joint work with Amru Hussein and Martin Saal at TU Darmstadt.

Date:

Friday, Jan. 12 12:15-12:45

Kohei SOGA
Keio University

Title:

On convergence of Chorin's projection method to a Leray-Hopf weak solution

Abstract:

Finite difference approximation is an effective approach to prove existence of Leray-Hopf weak solutions to the incompressible Navier-Stokes equations on a bounded domain. Ladyzhenskaya demonstrates a lot about this issue in her book, where she discretizes the equations including the pressure term and the divergence-free constraint. Chorin ('69) presents a discrete version of the Helmholtz decomposition operator, which is applied to a finite difference scheme similar to Ladyzhenskaya's in such a way that the non-divergence-free part of a difference solution is eliminated at each time step. Although these two methods seem mathematically equivalent, the actual computational process (on a computer) of operating the discrete Helmholtz decomposition operator is simpler or quicker than solving the whole equations with the pressure term and the divergence-free constraint. Hence, Chorin's approach is widely used as "Chorin's projection method". Since Navier-Stokes equations are nonlinear and the finite difference schemes are implicit, convergence of Chorin's projection method does not follow from Ladyzhenskaya's results. Chorin shows convergence and error estimates of his scheme, assuming that there is an exact C^5-solution. Temam ('69) announces finite difference schemes which are convergent to Leray-Hopf weak solutions, modifying Ladyzhenskaya and Chorin's frameworks to be more abstract and compatible with functional analytic arguments. Unfortunately, Temam's schemes do not seem friendly to practical numerical simulations as Chorin pointed out.

In this talk, I show slightly modified Chorin's projection method, which is different from Temam's schemes. The reason for our modification is that the original Chorin's scheme fails to give a closed L^2-energy estimate. We slightly change the nonlinear term to obtain nice estimates. Then, adjusting well-known compactness results to our discrete setting, we discuss weak and strong convergence of the scheme.

Date:

Tuesday, Jan. 09 15:10-15:40

Ryo TAKADA
Kyushu University

Faculty of Mathematics, Kyushu University
Fukuoka 819-0395, JAPAN

Title:

Strongly stratified limit for the 3D inviscid Boussinesq equations

Abstract:

We consider the initial value problem for the 3D inviscid Boussinesq equations with the effect of stable stratification:

$$\begin{cases} \partial_t v + (v\cdot\nabla)v = -\nabla q + \theta e_3 & t>0,\ x\in\mathbb{R}^3, \\ \partial_t\theta + (v\cdot\nabla)\theta = -N^2 v_3 & t>0,\ x\in\mathbb{R}^3, \\ \nabla\cdot v = 0 & t\geqslant 0,\ x\in\mathbb{R}^3, \\ v(0,x)=v_0(x), \quad \theta(0,x)=\theta_0(x) & x\in\mathbb{R}^3. \end{cases} \qquad (B_N)$$

Here, $N > 0$ is the Brunt-Väisälä (buoyancy) frequency for the constant stratification. The system (B_N) is derived from the original Boussinesq equations by considering the perturbation about a mean state in hydrostatic balance.

In this talk, we consider the singular limit as $N \to \infty$, and show that the classical solution v^N of (B_N) converges to that of the 2D Euler equations. The key ingredients of the proof are to introduce the modified linear dispersive solutions, and the inhomogeneous Strichartz estimates for the linear propagator related to the stable stratification.

Date:

Tuesday, Jan. 09 14:30-15:00

Patrick TOLKSDORF

Technical University of Darmstadt
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Title:

Morrey regularity of solutions to the Stokes equations in three-dimensional bounded Lipschitz domains

Abstract:

Let $\Omega \subset \mathbb{R}^3$ be a bounded Lipschitz domain. Then, we define for $1 < p < \infty$ and $0 \le \lambda < 3$ the Morrey space

$$\mathrm{L}^{p,\lambda}(\Omega) := \{f \in \mathrm{L}^p(\Omega) : \|f\|_{\mathrm{L}^{p,\lambda}(\Omega)} < \infty\},$$

where

$$\|f\|^p_{\mathrm{L}^{p,\lambda}(\Omega)} := \sup_{\substack{x_0\in\overline{\Omega} \\ 0<r<\mathrm{diam}(\Omega)}} r^{-\lambda} \int_{B(x_0,r)\cap\Omega} |f(x)|^p \, \mathrm{d}x.$$

For $f \in \mathrm{L}^{p,\lambda}(\Omega)$ and $p \ge 2$, we consider solutions u to the Stokes equations

$$\begin{cases} -\Delta u + \nabla\pi = f & \text{in } \Omega \\ \mathrm{div}(u) = 0 & \text{in } \Omega \\ u = 0 & \text{on } \partial\Omega \end{cases}$$

and ask whether u lies in $\mathrm{L}^{p,\lambda}(\Omega)$ as well, i.e., we ask for the boundedness of the operator $A^{-1} : \mathrm{L}^{p,\lambda}(\Omega) \to \mathrm{L}^{p,\lambda}(\Omega)$, where A denotes the Stokes operator.

To prove the boundedness, we first investigate the case $p = 2$ and prove by means of some classical estimates the boundedness of this operator by using a characterization of Morrey spaces by so-called Morrey–Campanato spaces. Once this is achieved, we present a generalization of a Calderón–Zygmund theorem, which allows to extrapolate bounded operators in $\mathcal{L}(\mathrm{L}^2(\Omega)) \cap \mathcal{L}(\mathrm{L}^{2,\lambda}(\Omega))$ to bounded operators in $\mathcal{L}(\mathrm{L}^p(\Omega)) \cap \mathcal{L}(\mathrm{L}^{p,\lambda}(\Omega))$ for $p > 2$. Finally, we sketch how to verify the requirements of this $\mathrm{L}^{p,\lambda}$-extrapolation theorem in the case of the Stokes system above.

This talk presents a work in progress and is a joint work with Martin Saal from Technische Universität Darmstadt.

Date:

Friday, Jan. 12 14:30-15:00

Kazuyuki TSUDA

Osaka University

Title:

Diffusive property and smoothing effect for solution to the compressible Navier-Stokes-Korteweg equation

Abstract:

Time decay estimate of a solution to the compressible Navier-Stokes-Korteweg system is studied. It is known that the system describes two phase flow with phase transition between liquid and vapor as a diffuse interface model in a compressible fluid. Concerning time decay estimate, Wang and Tan ([3]) show convergence rates of L^2 norm of a solution for 3 dimensional case under small initial value around constant state. The decay rate is same as that of heat kernel. In this talk concerning the linearized problem, the decay estimates with diffusive wave property (Cf., [1, 2]) for initial date are derived. Furthermore, as an application, we give time decay estimate of a solution to nonlinear system.

In contrast to the compressible Navier-Stokes system, for linear system regularities of initial dates are lower and independent of the order of derivative of the solution owing to smoothing effect from the Korteweg tensor. Furthermore, for the nonlinear system diffusive wave properties are obtained with initial dates having lower regularity than that of studies of the compressible Navier-Stokes system and [3].

References:

[1] D. Hoff and K. Zumbrun, Multi-dimensional diffusion waves for the Navier-Stokes equations of compressible flow, Indiana Univ. Math. J., **44**, (1995), pp.603–676.

[2] T. Kobayashi and Y. Shibata, Remark on the rate of decay of solutions to linearized compressible Navier-Stokes equations, Pacific Journal of Mathematics, **207** (2002), pp. 199–234.

[3] Y. Wang and Z. Tan, Optimal decay rates for the compressible fluid models of Korteweg type, J. Math. Anal. Appl., **379** (2011), pp. 256–271.

Date:

Tuesday, Jan. 09 16:55-17:25

Shinya UCHIUMI

Waseda University

Title:

A pressure-stabilized finite element method with higher-order elements

Abstract:

We consider a finite element method for the Navier-Stokes problem and its linearized problem for small viscosity.

One issue in these problems is treatment of the material derivative term. In convection-dominated flow problems, it is important to put weight on information in the upwind direction to make schemes stable. We here use the Lagrange-Galerkin (LG) method, which is a mixed method of the characteristics and the finite element method. One of the advantages of this method is that the resultant matrix is symmetric, which allows us to use efficient linear solvers. Recently a LG scheme with a locally linearized velocity has been developed (Tabata-Uchiumi, Math. Comp., 2018) to solve discrepancy between the convergence theory and actual computation arising from the difficulty in the computation of integration in a composite function. There the inf-sup stable P2/P1-element was used.

Here we combine this method to a pressure-stabilized method for the flow problems with small viscosity. In the scheme we use the equal-order approximation of order k for both the velocity and pressure, and add a symmetric pressure stabilization term. Symmetry of the LG method is inherited. Note the fact that, apart from the issue of the material derivative in these problems, dependence on the viscosity appears even in the simpler Stokes problems. We show a theoretical result that shows efficiency for small viscosity. We also show numerical examples that reflect the result.

Date:

Wednesday, Jan. 10 15:10-15:40

Erika USHIKOSHI

Yokohama National University

Title:

On Hadamard's formula of the Stokes equations

Abstract:

Let $\Omega \subset \mathbb{R}^3$ be a bouded domain with a smooth boundary $\partial\Omega$. For any $\varepsilon \geq 0$ and for any $\rho \in C^\infty(\partial\Omega)$, we define a perturbed domain by Ω_ε, whose boundary is $\partial\Omega_\varepsilon := \{y + \varepsilon\rho(y)\nu_y \ ; \ y \in \partial\Omega\}$. Here, ν_y is a unit outer normal vector at $y \in \partial\Omega$. Under such a perturbation, we consider the eigenvalue problem of the Stokes equations with a slip boundary condition;

$$\begin{cases} \Delta\mathbf{\Phi}(x) + \lambda(\varepsilon)\mathbf{\Phi}(x) = \nabla q(x), & x \in \Omega(\varepsilon), \\ \operatorname{div}\mathbf{\Phi}(x) = 0, & x \in \Omega(\varepsilon), \\ (2e(\mathbf{\Phi})\nu(x) + \kappa\mathbf{\Phi}(x)) \times \nu(x) = 0, \quad \mathbf{\Phi}(x)\cdot\nu(x) = 0, & x \in \partial\Omega(\varepsilon), \end{cases} \tag{0.1}$$

where κ is a positive friction constant, and $\{e_{ij}\}_{i,j=1,2,3}$ is a deformation tensor defined by $e_{ij}(\Phi) = \dfrac{1}{2}\left(\dfrac{\partial\Phi^i}{\partial x^j} + \dfrac{\partial\Phi^j}{\partial x^i}\right)$, $i,j = 1,2,3$. We see that the the spectral set of the Stokes equations with a slip boundary condition (0.1) consists of a descrete sequence of positive number. If we arrange them with counting multiplicity in increasing order, we have

$$0 < \lambda_1(\varepsilon) \leq \lambda_2(\varepsilon) \leq \lambda_3(\varepsilon) \leq \cdots \leq \lambda_m(\varepsilon) \leq \cdots \to \infty,$$

where the m-th eigenvalue is denoted by $\lambda_m(\varepsilon)$. In this talk, we consider ε-dependency of the eigenvalue having the multiplicity, and establish the Hadamard variational formula for that. This is a joint work with Professor Shuichi Jimbo(Hokkaido University).

Date:

Thursday, Jan. 11 16:55-17:25

10 minutes talks

Ken FURUKAWA

The University of Tokyo

Title:

Asymptotic stability of the three-dimensional Oseen vortex.

Abstract:

In this talk, we consider asymptotic stability of the three-dimensional Oseen vortex in the vertically periodic Euclidean space. First, we will construct a weak solution to the perturbed equation with logarithmic energy estimate. Next, we will show the decay of the solution by using Fourier expansion in vertical variable. The main term is the averaged term. We can show the decay of it by using same argument in 2-dimensional case.

Date:

Wednesday, Jan. 10 17:35-18:15

Mathis GRIES

Technical University of Darmstadt

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Title:

The hydrostatic Stokes semigroup and primitive equations with Dirichlet boundary conditions on spaces of bounded functions

Abstract:

The primitive equations and its linearized form, called the *hydrostatic Stokes equations*, are presented in spaces with norms of the L^∞-type. The impact of Dirichlet boundary conditions is discussed with an emphasis on semigroup estimates, which are used to construct local solutions to the full problem.

Date:

Tuesday, Jan. 09 17:35-18:15

Mitsuo HIGAKI

Kyoto University

Title:

On fast rotating time-periodic flows in a two-dimensional cylindrical domain

Abstract:

We consider the two-dimensional Navier-Stokes equations in a domain bounded by two coaxial cylinders, where the outer cylinder is fixed and the inner cylinder rotates fast. It is classical that there is an exact stationary solution for any rotating

speed, which is called the Couette flow. The main aim of this talk is to construct a time-periodic solution around the Couette flow by imposing a suitable external force. Moreover, in the fast rotation case we describe a boundary layer structure of the flow near the two boundaries. These results have been obtained in a joint work with Prof. Isabelle Gallagher (Universite Paris-Diderot and DMA, Ecole Normale Superieure) and Prof. Yasunori Maekawa (Kyoto University).

Date:

Friday, Jan. 12 16:15-16:55

Naoto KAJIWARA

The University of Tokyo

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Title:

Well-posedness for the phase-field Navier-Stokes equations in the maximal regularity space

Abstract:

We study the phase-field Navier-Stokes equations in the maximal regularity space. This equation models the dynamics of vesicle membranes in incompressible viscous fluids (e.g. red blood cells in the body). The description of the membrane is given the terms of a phase field function φ, i.e. $\varphi \approx +1$ inside the vesicle membrane, $\varphi \approx -1$ outside and the thin transition layer of width is characterized by a small parameter ε. We transform the equations into a quasi-linear parabolic evolution equation and use the maximal L_p regularity theory to prove local well-posedness and global well-posedness if the initial data is close to the variational strict stable solution.

Date:

Tuesday, Jan. 09 17:35-18:15

Klaus KRESS

Technical University of Darmstadt

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Title:

Strong time-periodic solutions to the bidomain equations subject to arbitrary large forces

Abstract:

We consider the bidomain equations which are describing the electrical properties of the heart. First, we show the existence of a weak time-periodic solution to the bidomain system subject to arbitrary large forces. Then, we use a result on global existence of the initial value problem and a weak-strong uniqueness argument to

obtain the existence of a strong time-periodic solution.

This talk is based on a joint work with Prof. Yoshikazu Giga and Naoto Kajiwara (The University of Tokyo).

Date:

Tuesday, Jan. 09 17:35-18:15

Hana MIZEROVÁ

Czech Academy of Sciences

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Title:

Convergence of entropy stable numerical schemes for the Euler equations via dissipative measure-valued solutions

Abstract:

We study convergence of entropy stable numerical schemes for the compressible Euler equations. We establish a suitable consistency formulation and show that a family of numerical solutions generates Young measure which represents a dissipative measure-valued solution of the limit system. The weak-strong uniqueness principle implies that the numerical solution converges strongly to the strong solution of the limit system as long as the latter exists.

The content of this talk results from the collaboration with Eduard Feireisl (Czech Academy of Sciences) and Mária Lukáčová (University of Mainz).

Date:

Friday, Jan. 12 16:15-16:55

Kohei NAKAO

Shinshu University

Title:

Beale-Kato-Majda type extension criterion of smooth solutions to the Navier-Stokes equations

Abstract:

We shall establish Beale-Kato-Majda type extension criterion of smooth solutions to the Navier-Stokes equations. It is known that if a smooth solution u to the Navier-Stokes equations on $(0, T)$ satisfies $\int_0^T \|\mathrm{rot}\, u(\tau)\|_{L^\infty} d\tau < \infty$, then u can be continued to the smooth solution on $(0, T')$ for some $T' > T$. In this talk, we shall slightly relax this condition for extension of smooth solutions to the Navier-Stokes equations.

This is a joint work with Prof. Yasushi Taniuchi (Shinshu university).

Date:

Thursday, Jan. 11 17:35-18:15

Andreas SCHMIDT

Technical University of Darmstadt

Title:

Strong solutions of the Navier-Stokes equations with the Coulomb boundary condition

Abstract:

We will consider the Navier-Stokes equations with the Coulomb friction law boundary condition. This condition means that the solution can slip at the boundary once the tangential stress exceeds a given threshold. If that is the case, the tangential component of the solution has the opposite direction of the tangential stress. We will discuss the existence of strong solutions $u \in W_2^1(0,T;L^2(\Omega)) \cap L^2(0,T;H^2(\Omega))$ in a bounded domain Ω.

Date:

Thursday, Jan. 11 17:35-18:15

Anton SEYFERT

Technical University of Darmstadt

Title:

The Helmholtz-Weyl Decomposition in L^p on Exterior Domains

Abstract:

Given a vector field $u \in L^p(\Omega)$ defined on an arbitrary smooth three-dimensional exterior domain Ω, we will decompose it into a harmonic vector field, a gradient field and the curl of a vector field, each of them satisfying suitable boundary conditions. This extends a result of Kozono and Yanagisawa (2009), who considered analogous decompositions in the case of bounded domains, where the decompositions always turned out to be unique. In our case, this decomposition is unique for a wide range of desired boundary conditions and integration parameters p, but there are also cases, where it lacks either uniqueness or existence. Our construction is based on the solvability of the weak Neumann and Dirichlet problems, as well as the solvability of a system of weak Poisson problems with vanishing tangential or vanishing normal boundary condition.

Date:

Wednesday, Jan. 10 17:35-18:15

Suma'inna

Waseda University

Yoshihiro SHIBATA Waseda University

Title:

On some nonlinear problem for the thermoelastic plate equations

Abstract:

In this talk, we will discuss a non linear thermoelastic plate equation in general domain (Ω). The problem is formulated by the equation system:

$$\begin{aligned} u_{tt} + \Delta^2 u + \Delta\theta + b\Delta((\Delta u)^3) &= f_1, \quad \text{in } \Omega \times (0,\infty), \\ \theta_t - \Delta\theta - \Delta u_t &= f_2, \quad \text{in } \Omega \times (0,\infty). \end{aligned} \tag{1}$$

with $c \in \mathbf{R}$ is a positive constant, subject to the initial condition

$$\begin{aligned} u|_{t=0} &= u_0, \quad \text{in } \Omega, \\ u_t|_{t=0} &= u_1, \quad \text{in } \Omega, \\ \theta|_{t=0} &= \theta_0, \quad \text{in } \Omega, \end{aligned} \tag{2}$$

and the Dirichlet boundary condition

$$u|_\Gamma = \theta|_\Gamma = \partial_\nu u|_\Gamma = 0. \tag{3}$$

In equations (1), $u = u(x,t)$ denotes a vertical displacement at time t at the point $x = (x_1, \cdots, x_n) \in \Omega$ while $\theta = \theta(x,t)$ describes the temperature. The nonlinear term appearing in (1) represents the nature of magnitoelastic material due to a nonlinear dependence between the tension of deformation and stress.

In the previous research, we have proved the maximal L_p-L_q-regularity for the linearized problem (1) - (3) ($b = 0$). By using this result, we shall prove the unique solutions of the equations (1) - (3) with the help of the fix point theorem.

Date:

Wednesday, Jan. 10 17:35-18:15

Yuka TERAMOTO

Kyushu University

Title:

On the spectrum of linear artificial compressible system

Abstract:

We consider the stability of stationary solutions of the incompressible Navier-Stokes system and the corresponding artificial compressible system. The sets of stationary solutions of both systems are the same and the incompressible system is obtained from the artificial compressible one as the limit the artificial Mach number ϵ to 0 which is a singular limit. It is proved that if a stationary solution of the incompressible system is asymptotically stable and the velocity field of the stationary solution satisfies an energy-type stability criterion by variational method with admissible functions being only potential flow parts of velocity fields, then it is also stable as a solution of the artificial compressible one for sufficiently small ϵ. The result can be applied to the Taylor problem.

Date:

Wednesday, Jan. 10 17:35-18:15

Hiroyuki TSURUMI

Waseda University

Title:

Well-posedness and ill-posedness of the stationary Navier-Stokes equations in Triebel-Lizorkin spaces

Abstract:

We consider the stationary Navier-Stokes equations in $\mathbb{R}^n$ for $n \geq 3$. First, we show existence and uniqueness of solutions in homogeneous Triebel-Lizorkin spaces $\dot{F}_{p.q}^{-1+\frac{n}{p}}$. We can show this well-posedness by the boundedness of the Riesz transform, the para-product formula, and the embedding theorem in homogeneous Triebel-Lizorkin spaces, using a method similar to that of Kaneko-Kozono-Shimizu in homogeneous Besov spaces. On the other hand, it is also proved that external forces whose $\dot{F}_{\infty,q}^{-3}$ norms are arbitrary small can produce solutions whose $\dot{F}_{\infty,q}^{-1}$ norms are arbitrary large. Such norm inflation phenomena are shown by constructing the sequence of external forces, as similar to those of initial data proposed by Bourgain-Pavlović in the non-stationary problem.

Date:

Thursday, Jan. 11 17:35-18:15

Keiichi WATANABE

Waseda University

Title:

Maximal regularity theorem of compressible-incompressible two-phase flows with phase transitions

Abstract:

We consider the free boundary problem for compressible-incompressible two-phase flows with phase transitions in a general domain. Two fluids are separated by a sharp interface and a surface tension is taken into account. The Navier-Stokes-Korteweg equation is used for the compressible fluid and the Navier-Stokes equation is used for the incompressible fluid. We seek the solutions in a neighbourhood of a constant state $(\mathbf{u}_+, \mathbf{u}_-, \rho_+, \pi_-, h) = (0, 0, \rho_{*+}, 0, 0)$, where $\mathbf{u}_\pm$ are velocity fields, ρ_+ is a density, π_- is a pressure field, h is a hight function, and ρ_{*+} is a positive constant. In this talk, we show the maximal L_p-L_q regularity of solutions to the linearized equations with the help of Weis's operator valued Fourier multiplier theorem. This work extends the result obtained by Shibata [Funkcial. Ekvac., 2016].

Date:

Tuesday, Jan. 09 17:35-18:15

David WEGMANN

Technical University of Darmstadt

Title:

Maximal Regularity for the Stokes Operator on non Cylindrical Time-space Domains: The Case of an Exterior Domain

Abstract:

For $t \in [0, \infty)$ let $\Omega(t)$ denote an exterior domain with sufficient smooth boundary and let $Q := \bigcup_t (\Omega(t) \times \{t\})$. We consider the Stokes equations

$$\begin{aligned} u_t - \Delta u + \nabla p &= f \text{ in } Q \\ \operatorname{div} u &= 0 \text{ in } Q \\ u(0) &= u_0 \text{ on } \Omega(0) \end{aligned} \tag{1}$$

in the non cylindrical time-space domain Q with Dirichlet boundary data. Assuming that there exists a sufficient smooth diffeomorphism from $\Omega(0)$ to $\Omega(t)$ we proved that the system (1) has maximal regularity. Note that this improves [2] since our result is globally in time.

The proof is based on ra esult of Giga, Giga and Sohr [1] and a perturbation argument for operators with bounded H^∞-calculus.

This is a result of a collaboration with Prof. Dr. Reinhard Farwig and Prof. Dr. Hideo Kozono.

References:

[1] Mariko Giga, Yoshikazu Giga, and Hermann Sohr, *L^p estimate for abstract linear parabolic equations*, Proc. Japan Acad. Ser. A Math. Sci. **67** (1991), no. 6, 197–202. MR1120516

[2] Jürgen Saal, *Maximal regularity for the Stokes system on noncylindrical space-time domains*, J. Math. Soc. Japan **58** (2006), no. 3, 617–641. MR2254403

Date:

Thursday, Jan. 11 17:35-18:15

Marc WRONA

Technical University of Darmstadt

Title:

Well-posedness of the Q-tensor model with nontrivial tumbling and aligning effects

Abstract:

In this work on *liquid crystals*, we use the most comprehensive description of nematics, namely the *Q-tensor*, proposed by P.G. de Gennes, which can - other than the Ericksen-Leslie model - describe line defects and biaxial configurations. For a sufficiently small ratio of tumbling and alignment effects (denoted by ξ), the existence of a unique strong solution is shown. This solution extends to a global strong solution, provided the initial data are small enough. To this end we use a *quasilinear approach*. More precisely, an abstract local well-posedness property for a certain class of quasilinear operators and nonlinear terms as well as the *maximal regularity* of a tri-diagonal differential operator plus a small perturbation are proved. The results are due to a joint work with Matthias Hieber and Miho Murata.

Date:

Friday, Jan. 12 16:15-16:55

Sebastian ZAIGLER

Technical University of Darmstadt

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Title:

Regularity structures for the primitive equations

Abstract:

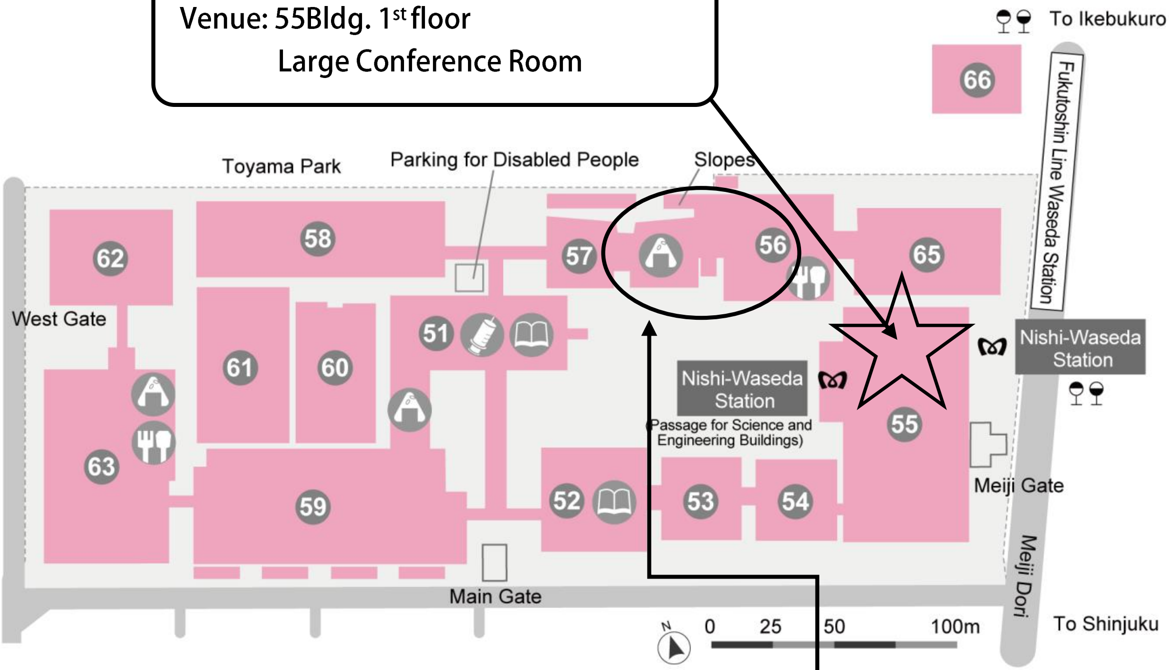
The new technique of regularity structures introduced by Martin Hairer is a method to find local solutions for subcritical SPDEs with rough data, which were formerly inaccessible. Regularity structures are spaces of abstract “Taylor expansions”, in which a solution of a SPDE can be found by solving fixed point equations. The sequence of these fixed points, which are renormalised solution of the SPDE, converges to a solution of the SPDE. We will give a short introduction how to modify them to solve the primitive equations with white noise.

Date:

Friday, Jan. 12 16:15-16:55

Nishi-Waseda Campus Map

Venue: 55Bldg. 1st floor
Large Conference Room



Basement floor:
Foods Shop (10:00-15:00)
and Cafeteria (11:30-13:30)

Organizers : Reinhard FARWIG (TU Darmstadt)
Matthias HIEBER (TU Darmstadt and Waseda University)
Hideo KOZONO (Waseda University)
Yoshihiro SHIBATA (Waseda University)

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Supported by:

- Multiscale Analysis, Modelling and Simulation, Top Global University Project, Waseda University
- Institute of Mathematical Fluid Dynamics, Waseda University
- JSPS Grant No. 16H06339, New development of mathematical theory of turbulence by collaboration of the nonlinear analysis and computational fluid dynamics (Hideo KOZONO)
- JSPS Grant No. 17H01097, Construction of Mathematical Theory of Two Phase Flows (Yoshihiro SHIBATA)