Mathematics and Physics Unit "Multiscale Analysis, Modelling and Simulation"
Top Global University Project, Waseda University

Waseda Workshop on Partial Differential Equations 2019 – December

Date: December 17, 2019
Venue: Meeting Room, Bldg. 62, Nishi-waseda Campus, Waseda University
早稲田大学 西早稲田キャンパス 62 号館 W 棟 1 階 大会議室

Pierangelo Marcati (GSSI: Gran Sasso Science Institute)

10:00 – 11:00

Splash Singularities for a General Oldroyd-B Model for Viscoelastic Fluids

We study a 2D free-boundary Oldroyd-B model which describes the evolution of a viscoelastic fluid. We prove the existence of splash singularities, namely points where the free-boundary remains smooth but self-intersects. We study both infinite and the more realistic physical case of finite Weissenberg number. The main difficulty faced in the general is due to the non-linear balance law of the elastic tensor, which cannot be reduced, as in the case of infinite Weissenberg, to a transport equation for the deformation gradient. The methods are based on the combined use of conformal transformations and Lagrangian coordinates, whose formulation must however take into account the general balance law of the elastic tensor and its dependence on the Weissenberg number. The existence of the splash singularities is therefore guaranteed by an adequate choice of initial data, depending also on the elastic tensor, combined with stability estimates.

BIBLIOGRAPHY
1-Di Iorio, Elena; Marcati, Pierangelo; Spirito, Stefano,
Splash singularities for a general Oldroyd model with finite Weissenbergnumber,
Arch. Rational Mech. Anal. - Online doi: 10.1007/s00205-019-01451-z

2-Di Iorio, Elena; Marcati, Pierangelo; Spirito, Stefano,
Splash singularity for a free boundary incompressible viscoelastic fluid model
(2018)ArXiv:1806.11089 – to appear Advances in Math.

Jiang Xu (Nanjing University of Aeronautics and Astronautics)

11:10 – 12:10

Fourier analysis methods and dissipative PDEs

The theory of dissipative symmetric systems was initiated by Godunov (1961) and further developed by Friedrichs-Lax (1971) and Kawashima (1984). Based on the point of view of ODEs, we can establish the global-in-time existence and time-decay results for hyperbolic systems of balance laws, Boltzmann equation, compressible Navier-Stokes equations and so on.

Yukihito Suzuki (Waseda University)

14:00 – 14:30

A GENERIC formalism for complex fluids with Cattaneo heat flux

In this talk, a GENERIC[1,2] formalism for complex fluids[3] with heat conduction which is modeled by Cattaneo's law[4] will be presented. The GENERIC, which is an abbreviation of General Equation for the Non-Equilibrium Reversible-Irreversible Coupling, serves as a general framework for the thermodynamically consistent modeling of continua. Additional structural variables, called the conformation tensor and Cattaneo heat flux, are introduced to model viscoelastic micro-structures and hyperbolic heat conduction, respectively. The conformation tensor is assumed to be contravariant whereas the Cattaneo heat flux vector is assumed to be covariant. Their time evolution along the flow, which is naturally represented by the Lie derivative, is prescribed by the Poisson bracket in the GENERIC formalism.

[1] Grmela, M., Öttinger, H. C. (1997) Dynamics and thermodynamics of complex fluids. I. Development of a general formalism, Phys. Rev. E 56, 6620-6632.
[2] Öttinger, H. C., Grmela, M. (1997) Dynamics and thermodynamics of complex fluids. II. Illustrations of a general formalism, Phys. Rev. E 56, 6633-6655.
[3] Öttinger, H. C. (2005) Beyond Equilibrium Thermodynamics, Wiley.
[4] Joseph, D. D., Preziosi, L. (1989) Heat waves, Rev. Mod. Phys. 61, 41-73.

Kenta Nakamura (Tohoku University)

14:40 – 15:10

On the asymptotic stability of rarefaction waves for hyperbolic systems of balance laws

In this talk, we consider the rarefaction waves for a model system of hyperbolic balance laws in the whole space and in the half space, respectively. We will give the results concerning the asymptotic stability of rarefaction waves under smallness assumptions on the initial perturbation, and on the amplitude of the waves. This talk is based on joint work with Prof. S. Kawashima, Waseda Univ.

Fumitaka Wakabayashi (Waseda University : D1)

15:30 – 16:00

Removability of moving singularities in the Stokes and Navier-Stokes equations

We consider the solutions of the Stokes and Naivier-Stokes equations with moving singularities in bounded domain Ω in R^3. It is known that for the heat equation the moving singularity $\xi(t)$ is removable if the singularity is weaker than the order of the fundamental solution to the Laplace equation, where $\xi(t)$ is locally $1/2$- Hölder continuous in $t \in R$. We give a similar necessary condition for the removability of moving singularities in the Stokes and Navier-Stokes equations.

Naofumi Mori (Tokyo University of Marine Science and Technology)

16:10 – 16:40

Global existence and asymptotic decay of solutions to a complex fluid system in 1D

Complex fluids are interesting materials and may include many examples such as shampoo, toothpaste, blood, liquid crystals, and so on. Some of them are considered as viscoelastic fluids. In this talk, we consider a model system of complex fluids first proposed by Ötinger (2005) in one-dimensional case. We observe that the model system is transformed into a hyperbolic system of balance laws. Then, we show that the system has a mathematical entropy and satisfies the stability condition first formulated by Shizuta and Kawashima (1985) for a general class of linear symmetric hyperbolic-parabolic systems. On the other hand, another condition was introduced by Umeda, Kawashima and Shizuta (1983) to derive the decay estimate of solutions for linearized symmetric hyperbolic-parabolic systems. This condition is now called "craftsmanship condition". We show that the system also satisfies the craftsmanship condition by constructing the matrix K concretely. As the result, by applying these general theories for hyperbolic balance laws, we can prove the global existence and asymptotic decay of solutions to our model system. This talk is based on a joint work with Profs. Yukihito Suzuki, Masashi Ohnawa and Shuichi Kawashima.

Ryosuke Nakasato (Tohoku University : D2)

17:00 – 17:30

Global well-posedness and time-decay estimates for the compressible hall-magnetohydrodynamic system in L^2 Besov framework

We study the initial value problem for the compressible hall-magnetohydrodynamic system (hereinafter referred to hall-MHD) in the whole space. We first focus on the solution of the linearized system that are close to some constant state $(\bar{\rho}, 0, \bar{B})$ with a positive constant $\bar{\rho}$ and nonzero vector $\bar{B}$ at infinity. For general systems which include the standard linearized compressible magnetohydrodynamic system, Umeda-Kawashima-Shizuta (1984) obtained the pointwise estimates of solutions in the Fourier space. In this talk, we shall explain the results on global well-posedness and time-decay estimates for the hall-MHD around $(\bar{\rho}, 0, \bar{B})$. Furthermore, we shall show the pointwise estimate for the linearized hall-MHD that is the same as the result of Umeda-Kawashima-Shizuta. This is based on the joint work with Profs. Shuichi Kawashima and Takayoshi Ogawa.

Xin Zhang (Waseda University)

17:40 – 18:10

The $\mathcal{R}-$bounded operator families arising from the study of the barotropic compressible flows with free surface

In this talk, we shall discuss some resolvent problem arising from the study of the free boundary value problem of the compressible Navier-Stokes equations (CNS) in the maximal $Lp - Lq$ regularity class. Here we assume that there exists some surface tension on the free surface Γ_t

and the domain Ω_t is not necessary bounded. By the approach of the Lagrangian coordinates, (CNS) can be transferred to some quasi-linear system in the initial domain Ω. Then we will see that the fundamental step is to prove the existence of the $\mathcal{R}-$boundedness of operator families of the linearized model in Ω. This can be attained by applying the operator-valued Fourier Multiplier theory of L. Weis in 2001.

Organized by Yoshihiro Shibata, Shuichi Kawashima, Hideo Kozono, Tohru Ozawa

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