HISHIDA, Toshiaki Professor

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Membership of academic societies:
Mathematical Society of Japan

Research Interest:

- Nonlinear partial differential equations
- Navier-Stokes system

Research Summary:

My research interest is focused on nonlinear partial differential equations (PDEs) arising from fluid mechanics. The motion of the fluid is essentially nonlinear, on the other hand, even at the level of linearized systems (around a background state), analysis is often involved. Furthermore, some qualitative properties (for instance, asymptotic structure at spatial infinity) of solutions could depend on the fluid region and on the motion of obstacles immersed there. Mathematical analysis of the Navier-Stokes system is traced back to a series of celebrated papers by Leray in 1930s. Later on, remarkable progress has been made by a lot mathematicians and it has always had much influence on analysis of some other PDEs. In spite of their efforts since the landmark by Leray, the following problem still remains open: The unique existence of regular solution globally in time without any smallness assumption on initial data no matter how smooth they are. Besides this, however, we have many other challenging problems, in particular, it is of utmost importance to find mathematical properties (asymptotic structure, stability, attainability,...) of flows arising in physically relevant situations, such as the flow past a rotating obstacle ([1], [5]) and even fluid-structure interaction ([4]).

Major Publications:

[1] T. Hishida, Large time behavior of a generalized Oseen evolution operator, with applications to the Navier-Stokes flow past a rotating obstacle, *Math. Ann.* **372** (2018), 915–949.

[2] T. Hishida, Stationary Navier-Stokes flow in exterior domains and Landau solutions, *Handbook of Mathematical Analysis in Mechanics of Viscous Fluids* 299–339, Springer, 2018.

[3] T. Hishida and P. Maremonti, Navier-Stokes flow past a rigid body: attainability of steady solutions as limits of unsteady weak solutions, starting and landing case, *J. Math. Fluid Mech.* **20** (2018), 771–800.

[4] T. Hishida, A. Silvestre and T. Takahashi, A boundary control problem for the steady self-propelled motion of a rigid body in a Navier-Stokes fluid, *Annales de l'Institut Henri Poincare / Analyse non lineaire* **34** (2017), 1507–1541.

[5] T. Hishida, Mathematical analysis of the equations for incompressible viscous fluid around a rotating obstacle, *Sugaku Expositions* **26** (2013), 149–179.

[6] T. Hishida, The nonstationary Stokes and Navier-Stokes flows through an aperture, *Contributions to Current Challenges in Mathematical Fluid Mechanics*, 79–123, *Adv. Math. Fluid Mech.*, Birkhäuser, Basel, 2004.

[7] T. Hishida, An existence theorem for the Navier-Stokes flow in the exterior of a rotating obstacle, *Arch. Rational Mech. Anal.* **150** (1999), 307–348.

Awards and Prizes:

- Analysis Prize (2007)

Education and Appointments:

1993 Dr. Sci., Waseda University
1993 Research Associate, Waseda University
1994 Research Associate, Kumamoto University
1997 Assistant Professor, Niigata University
2000 Associate Professor, Niigata University
2008 Professor, Nagoya University

Message to Prospective Students:

As the subject in the seminar of master course, I can propose, for instance, (1) elliptic PDEs of second order; (2) the method of functional analysis such as semigroup theory; (3) mathematical analysis of the Navier-Stokes system, which are related each other. As the textbook, I would recommend

1. L. C. Evans, Partial Differential Equations, Amer. Math. Soc., 1998.
2. D. Gilbarg and N. S. Trudinger, Elliptic Partial Differential Equations of Second Order, Springer, 1977.
3. H. Sohr, The Navier-Stokes Equations, An Elementary Functional Analytic Approach, Birkhäuser, 2001.
4. G. P. Galdi, An Introduction to the Mathematical Theory of the Navier-Stokes Equations, Steady Problems, Second Edition, Springer, 2011.
5. T.-P. Tsai, Lectures on Navier-Stokes Equations, Amer. Math. Soc., 2018.

For those who wish to proceed to the doctor course, they are asked to read some related papers. In the doctor course, what is important is to find a problem and to develop analysis by himself/herself. It might be better to work on a bit different subject from mine.