SUGIMOTO, Mitsuru Professor

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Membership of Academic Societies:
The Mathematical Society of Japan

Research Interest:

- partial differential equations
- Fourier analysis

Research Summary:

Various phenomena of nature can be treated mathematically by describing them in the language of partial differential equations (PDE). Through the analysis I aim to extract new principles which comprehend concrete phenomena. As a methodology of PDE, many properties of the solutions to PDE can be deduced from their *characteristics*, and I employ this idea to investigate quantitative properties of solutions like size, regularity, and so on. Simultaneously I proceed with the study of Fourier analysis as an important tool for such analysis.

That is the summary of my research, and I explain it in detail below. The tool Fourier integral operator (FIOp) was theorized by Hörmander et al. in the beginning of 1970's, and has been applied to the study of PDE in various situation. In particular, it enables us to discuss PDE after transforming them to their normal forms. FIOp is also used to express the solutions to Cauchy problems of hyperbolic and Schrödinger equations, and from the expression we can extract information on the position of singularities and how they are propagated. In this way, peculiar information on solutions governed by PDE is inherent in FIOp as algebraic or geometric structure.

On the other hand, non-linear analysis is one of the most active research fields in the modern theory of PDE, and many complex phenomena of nature have been clarified thorough it. Knowing size or regularity of solutions to PDE is an important task because they are reflected very sensitively in phenomena. But unexpectedly, it is not a straightforward task to extract all these information from FIOp. So we need help of Fourier analysis, and sometimes we need to develop Fourier analysis itself.

With the idea of pushing ahead with the quantitative analysis of PDE via FIOp for a background, I have studied so far the following subjects:

- "L^p-estimates for hyperbolic equations"
  To determine the relation between L^p-type estimates for hyperbolic equations and the geometrical structure of their characteristics.
- "Smoothing properties of dispersive equations"
  To understand why dispersive equations have extra gain of regularity if we take integral mean in time variable.

Recently I am trying to induce estimates for solutions to PDE by transforming them to their normal forms. As a great advantage of this method, we can understand the mechanism of estimates from a high position. Having prepared theories of FIOp and function spaces as the fundamental tools, I have successfully applied them to induce smoothing estimates for dispersive equations.

Major Publications:

[1] M. Sugimoto, A priori estimates for higher order hyperbolic equations, Math. Z. **215** (1994), 519–531.

[2] M. Ruzhansky and M. Sugimoto, A smoothing property of Schrödinger equations in the critical case, Math. Ann. **335** (2006), 645–673.

[3] N. Tomita and M. Sugimoto, The dilation property of modulation spaces and their inclusion relation with Besov spaces, J. Funct. Anal. **248** (2007), 79–106.

[4] M. Ruzhansky and M. Sugimoto, Structural resolvent estimates and derivative nonlinear Schrödinger equations, Comm. Math. Phys. **314** (2012), 281–304.

[5] M. Ruzhansky and M. Sugimoto, Smoothing properties of evolution equations via canonical transforms and comparison principle, Proc. London Math. Soc. **105** (2012), 393–423

Awards and Prizes:

- 2010, Daiwa Adrian Prizes, "Phase space analysis of partial differential equations"

Education and Appointments:

1992	PhD (University of Tsukuba)
1987–1990	Research Associate (University of Tsukuba)
1990–1998	Assistant Professor (Osaka University)
1998–2008	Associate Professor (Osaka University)
2008–	Professor (Nagoya University)

Message to Prospective Students:

PDE and Fourier analysis are tightly connected to each other, and are still developing under their mutual interaction. I advise students to pick one topic in either subject (or both subjects) and study it keeping other subject within his insight. The aim of this procedure is to get at least one specialty of their own. Some examples of possible textbooks are listed below:

1. G. B. Folland, Introduction to Partial Differential Equations, Princeton University Press 1995
2. G. Eskin, Lectures on Linear Partial Differential Equations, American Mathematical Soc. 2011
3. E. M. Stein, Harmonic analysis: real-variable methods, orthogonality, and oscillatory integrals, Princeton University Press 1993
4. L. Grafakos, Classical Fourier Analysis, Springer 2008
5. K. Gröchenig, Foundation of Time-Frequency Analysis, Birkhäuser 2001

For further study, I often encourage students to read (and write if possible) research papers.