Computational Mathematics Seminar Series

Inverse Problems for PDEs: Analysis, Computation, and Applications

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Digital Media Center 1034
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Abstract:

Inverse problems for PDEs arise in diverse areas of industrial and military applications, such as nondestructive testing, seismic imaging, submarine detections, near-field and nano optical imaging, and medical imaging. A model problem in wave propagation is concerned with a plane wave incident on a medium enclosed by a bounded domain. Given the incident field, the direct problem is to determine the scattered field for the known scatterer. The inverse problem is to determine the scatterer from the boundary measurements of near field currents densities. Although this is a classical problem in mathematical physics, mathematical issues and numerical solution of the inverse problems remain to be challenging since the problems are nonlinear, large-scale, and most of all ill-posed! The severe ill-posedness has thus far limited in many ways the scope of inverse problem methods in practical applications. In this talk, the speaker will first introduce inverse problems for PDEs and discuss the state of the arts of the inverse problems. Our recent progress in mathematical analysis and computational studies of the inverse boundary value problems will be reported. Several classes of inverse problems will be studied, including inverse medium problems, inverse source problems, inverse obstacle problems, and inverse waveguide problems. A novel stable continuation approach based on the uncertainty principle will be presented. By using multi-frequency or multi-spatial frequency boundary data, our approach is shown to overcome the ill-posedness for the inverse problems. New stability results and techniques for the inverse problems will be presented. Related topics will be highlighted.

Speaker's Bio:

Gang Bao, National Chair Professor (``One Thousand Talent Program'', 2010-present and Dean of the School of Mathematical Sciences at Zhejiang University. He is also a Co-Director of the ZJU-Imperial College Joint Lab on Applied Data Science. After his PhD degree at Rice University in 1991, he was a Research Associate at Rice University (1991-1992) and the IMA, University of Minnesota (1992-1994), Assistant and Tenured Associate Professor at University of Florida (1994-1999), and Full Professor at Michigan State University (1999-2014). He was the Founding Director of the Michigan Centre for Industrial and Applied Mathematics at Michigan State University (2006-2014). A recipient of the Feng Kang Prize on Scientific Computing in 2003 and the MSU University Distinguished Faculty Award in 2007, Dr. Bao's research interests include inverse problems for partial differential equations; mathematics and computation of diffractive optics, nonlinear optics, near-field and nano-optics, and electromagnetics; multi-scale, multi-physics scientific computing. He has published over 150 papers in leading research journals including J. Ameri. Math. Soc.□Trans of AMS, Math. Comp., Arch. Rational Mech. Anal., J. Math. Pures Appl., as well as J. Comput Phys. and several SIAM/IEEE/OSA Journals. Dr. Bao has served on the editorial boards of over ten international research journals on mathematics including SIAM J. Appl. Math, Multiscale Modeling and Simulation (SIAM), J. Differential Equations, Inverse Problems, Inverse Problems and Imaging, and Comm. Comput. Phys.

This lecture has a reception @ 03:00 pm

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