Inverse Problems

Inverse Problems are problems where causes for a desired or an observed effect are to be determined. They lie at the heart of scientific inquiry and technological development. Applications include a number of medical as well as other imaging techniques, location of oil and mineral deposits in the earth’s substructure, creation of astrophysical images from telescope data, finding cracks and interfaces within materials, shape optimization, model identification in growth processes and, more recently, modelling in the life sciences.

The workshop will consist of four 4 minicourses of 2 hours each that will give an introduction to several of the topics discussed in the Introductory Workshop the following week as well as topics that will be discussed during the Fall semester. A brief description of each minicourse follows.

• An Introduction to Microlocal Analysis
  Lecturer: Tanya Christiansen (U. of Missouri, Columbia)
  Microlocal analysis is useful in understanding solutions of differential equations. Pseudodifferential operators arise, for example, in inverting elliptic differential equations. We introduce pseudodifferential operators and their mapping properties. We will see that the notion of the “wave front set” of a function is very helpful in describing its singularities.

References


• An Introduction To Seismic Imaging
  Lecturer: Alison Malcolm (MIT)
  This course will give a broad overview of seismic imaging techniques, highlighting their underlying relationships to imaging in other fields (e.g. radar and ultrasound). We will begin with the Generalized Radon Transform, progress to one-way methods using a microlocal splitting of the wave equation into up- and down-going waves, and finish with a discussion of so-called reverse-time migration in which the full wave equation is run backwards in time to form an image. We will discuss the approximations underlying each method and their relative importance and will briefly discuss extensions beyond single-scattering.

References


• An Introduction to Asymptotic Expansions for Small Inhomogeneities in EIT and Related Problems
  Lecturer: Sharil Moskow (Drexel U.)
  We discuss the basic tools and derivation of series expansions for potential data in the presence of small volume inhomogeneities which are different from a smooth background conductivity.
We explain what properties can be recovered from the series terms and give a few ideas about how these expansions can be used to do inversion.

References


- Coherent Imaging in Random Media

Lecturer: Chrysoula Tsogka (U. of Crete)

We consider the problem of array imaging in cluttered media, in regimes with significant multiple scattering of the waves by the inhomogeneities. In such scattering regimes, the recorded traces at the array have long and noisy codas and classic imaging methods give unstable results. We will discuss coherent statistically stable imaging methodologies for imaging in such regimes.

References


