FMSP Lectures

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Complex principal type operators in inverse conductivity problem

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Abstract:

Stroke is a leading cause of death all around the world. There are two main types of stroke: ischemic (blood clot preventing blood flow to a part of the brain) and hemorrhagic (bleeding in the brain). The symptoms are the same, but treatments very different. A portable "stroke classifier" would be a life-saving equipment to have in ambulances, but so far it does not exist. Electrical Impedance Tomography (EIT) is a promising and harmless imaging method for stroke classification. In EIT one attempts to recover the electric conductivity inside a domain from electric boundary measurements. This is a nonlinear and ill-posed inverse problem. The so-called Complex Geometric Optics (CGO) solutions have proven to be a useful computational tool for reconstruction tasks in EIT. A new property of CGO solutions is presented, showing that a one-dimensional Fourier transform in the spectral variable provides a connection to parallel-beam Xray tomography of the conductivity. One of the consequences of this “nonlinear Fourier slice theorem” is a novel capability to recover inclusions within inclusions in EIT. In practical imaging, measurement noise causes strong blurring in the recovered profile functions. However, machine learning algorithms can be combined with the nonlinear PDE techniques in a fruitful way. As an example, simulated strokes are classified into hemorrhagic and ischemic using EIT measurements.