


复旦大学数学科学学院

数学综合报告会

报告题目：Local reconstruction of coefficients in quantitative photoacoustic tomography

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报告摘要：

Quantitative photoacoustic tomography (QPAT) seeks to recover optical parameters of a medium from internal absorbed-energy data generated by optical illumination and measured through acoustic waves [1, 3]. In practice, these data are most reliable only near the illuminated boundary, since attenuation and limited detector sensitivity reduce their usefulness at greater depth [1, 5]. This motivates a local inverse problem: reconstructing the absorption and scattering coefficients only in a boundary layer where the signal remains informative [4, 2]. We consider the stationary radiative transport equation [3, 5] in a smooth bounded domain, with absorption coefficient μ_a, scattering coefficient μ_s, and a prescribed scattering kernel. For a given inflow illumination g, the internal data take the form

$$H(x, g) = \mu_a(x) \int_{\mathbb{S}^{n-1}} u(x, d)\, ds(d),$$

where u denotes the photon density, solution to the radiative transport equation. We show that with a finite number of suitably chosen illuminations, one obtains a local linear system whose invertibility guarantees unique recovery of the coefficients up to higher-order depth errors. The analysis provides a rigorous explanation of depth-limited resolution in (QPAT) and suggests a practical reconstruction strategy in strongly attenuating media. Numerical experiments support the asymptotic model and illustrate stable coefficient recovery in shallow subregions near the boundary.

This is a joint work with Mirza Karamehmedović (DTU, Danemark).

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