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2D Optical Tomography in Critical Regime

Optical tomography is a potential imaging method in medical diagnosis, which uses near-infrared radiation. The mathematical model is based on the transport equation

$$\theta \cdot \nabla u(x,\theta) + a(x)u(x,\theta) = \int_{\mathbf{S}^1} k(x,\theta\cdot\theta')u(x,\theta')d\theta', \; x \in \Omega, \; \theta \in \mathbf{S}^1.$$

When no collided particles get absorbed, the balance between the total cross section and scatter is given by $\int_{\mathbf{S}^1} k(x,\theta\cdot\theta')d\theta' = a(x)$. When scattering is large, the flux u is near linear in θ. A linearity assumption reduces the transport equation to a diffusion equation. Moreover, knowledge of the albedo operator (boundary data operator) translates into knowledge of the Dirichlet-to-Neumann map. The $\bar{\partial}$-method applied to the diffusion equation recovers $k_1(x) = \int_{\mathbf{S}^1} \theta\cdot\theta' k(x,\theta\cdot\theta')d\theta$.