A mollification method for thermoacoustic computed tomography in spherical geometry

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Thermoacoustic computed tomography (TCT) is a novel and promising imaging technique for nondestructive testing and medical imaging. It relies on the thermoacoustic effect: Exposing a probe to pulsed electromagnetic signals such as radio waves or laser causes a thermal expansion of the object and a subsequent pressure field. This pressure field is described by the wave equation

$$\Big(\frac{\partial^2}{\partial t^2} - \Delta\Big)p(x,t) = f(x)\frac{\partial j}{\partial t}$$

where $f(x)$ denotes the energy deposition, j is the electromagnetic impulse. Together with appropriate initial values the unique solution is given as

$$p = \frac{\partial j}{\partial t} *_t (t\mathbf{M}f)$$

with the spherical mean operator

$$\mathbf{M}f(x,t) = \frac{1}{4\pi}\int_{S^2} f(x+t\omega)\,d\Omega(\omega)\,.$$

The inverse problem of TCT consists of recovering the energy deposition f, which gives information about inhomogeneities within the probe, from the measured pressure field p.

In the talk we introduce to the problem of TCT and present an inversion algorithm relying on the method of approximate inverse. The idea of this method consists in computing moments of the searched for function f with so-called mollifiers yielding a smooth approximation to the original f. This can be done by evaluating inner products of the measurement data with reconstruction kernels. The translation invariance of the mollifier is transmitted to the reconstruction kernel and hence leads to an inversion method of filtered backprojection type. Numerical results from exact and noisy data complete the talk.