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On solving the inverse problem of diffractive tensor tomography via a transport equation

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The author discusses a method for dynamic tensor field tomography, which involves recovering a tensor field from its longitudinal ray transform in an inhomogeneous medium. The refractive index of the medium generates the Riemannian metric in the domain, and the goal is to solve the inverse source problem for the associated transport equation. While there are many results for recovering tensor fields in a static Euclidean setting, there are few inversion formulas and algorithms for general Riemannian metrics and time-dependent tensor fields. Tensor field tomography is equivalent to an inverse source problem for a transport equation, with the ray transform as given boundary data. In the dynamic case, the same approach can be used. To ensure the forward mappings are well-defined, existence and uniqueness for the transport equations must be proven. Unfortunately, the bilinear forms of the weak formulations do not satisfy the coercivity condition, so viscosity solutions are used instead. The author provides numerical evidence that the viscosity solution solves the original transport equation when the viscosity term is zero. Additionally, numerical experiments for the static case are discussed. It turns out that the adjoint mapping can also be expressed as solution of a transport equation and be solved by the method of characteristics. Numerical results for the reconstruction of stationary fields are given.

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