

A Journey through the State-of-the-Art of Non-Iterative Approach to Inverse Scattering, Open Questions and Future Prospects

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Inverse scattering theory is central to diverse applications such as medical imaging, geo-physical exploration, and nondestructive testing. The growth of this field has been characterized by the fact that the inverse scattering problem is both nonlinear and ill-posed, thus presenting mathematical and computational challenges. Until not long ago, essentially all existing algorithms for solving inverse scattering problems were based on either a weak scattering approximation or on the use of nonlinear optimization techniques. It was realized that for many contemporary practical applications such as the imaging of complicated engineered structures, nonlinear optimization techniques require a prior information and accurate models that are in general not available. Hence alternative methods for imaging have been developed which avoid incorrect model assumptions in linearization but, as opposed to nonlinear optimization techniques do not rely on iterative solution of the forward model. They are non-iterative and yield mathematically justified and computationally simple reconstruction algorithms by exploiting properties of the linear scattering operator to decode non-linear information about the scattering object. In particular their mathematical analysis has led to some interesting and challenging mathematical questions.

In this review talk I will present the state of the art of these approaches, related open mathematical and computational questions, and their future prospects within the current trends in the fields of inverse scattering and data science.