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Far field operator splitting and completion for inhomogeneous medium scattering

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We consider scattering of time-harmonic acoustic waves by an ensemble of compactly supported penetrable scattering objects in 2D.
These scattering objects are illuminated by an incident plane wave.
The resulting total wave is the superposition of incident and scattered wave and solves a scattering problem for the Helmholtz equation.
For guaranteeing uniqueness, the scattered wave must fulfill the Sommerfeld radiation condition at infinity.

In our consideration, measurements of the total wave are replaced by the corresponding far field operator.
This operator contains all information about the scattered wave far away from the scattering objects for all possible illumination directions.

We are interested in two inverse problems.
On the one hand, given a limited observation of this far field operator, we want to determine its missing part, which we refer to as operator completion problem.
'Limited observation' in this context means, that we do not have access to measurements for all illumination directions or that we cannot measure in all observation directions around the scattering objects.
On the other hand, given the far field operator for the ensemble of scattering objects, we want to determine the far field operators of the individual scattering objects.
This is what we refer to as operator splitting problem.
Multiple reflection effects cause, in contrast to the first problem, the nonlinearity of this second problem.

We characterize spaces containing the individual, for the two problems relevant components of the far field operator.
Operators in these spaces turn out to have a low rank and sparsity properties with respect to some known modulated Fourier frame.
Furthermore, this rank and frame can be determined under knowledge of the locations and sizes of the scatterer's components.

In my talk I will suggest two reformulations of the inverse problems, a least squares norm formulation and a $l^1 \times l^1$-norm minimization, and appropriate algorithms for solving these formulations numerically.
Moreover, I will present stability results for these reconstructions and support them by numerical experiments.

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