Linear inverse scattering of strip objects above a reflecting plane

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It is known that the inverse scattering problem can benefit from reflections and scattering introduced by the hosting medium in that reflections and scattering effects can introduce a surplus of spatial diversity and can provide additional information about the probed scene.
This behaviour is necessarily linked to the mathematical "structure" of the scattering operators pertinent to a multipath background scene. Therefore, it is our commitment to study here the role played by those multipath effects by analysing the singular value decomposition (SVD) of such operators. In particular, knowing the SVD analytically would allow to highlight the role played by the parameters of the configuration.

Consider a strip object that scatterers in presence of a reflecting plane once illuminated normally by a single plane wave. The scattered field is collected in the far zone. Invariance is assumed along the plane wave polarization direction so the problem is addressed for a two-dimensional scalar configuration. Both the cases of orthogonal and parallel (to the reflecting plane) scatterers are considered, while the reflecting plane can be made up of a perfect electric or magnetic conductor or consisting of an interface separating two homogeneous half-spaces.
Analytical arguments are developed to estimate the SVD of the scattering operator and the point-spread function. If the scatterer is orthogonal to a perfect reflecting plane the SVD can be obtained in closed form. In other cases we can proceed as in (R. Solimene, M. A. Maisto, R. Pierri, *J. Opt. Soc.* A **30**, pp. 2266-2272) obtaining a couple of auxiliary operators which allow to get upper and lower estimations of the singular values of the scattering operator.

Our analysis highlighted that when the scatterer is orthogonal to a perfect reflecting plane, the singular values exhibit a step-like behaviour and the NDF is twice as large as the NDF in homogeneous medium. This entails halving of the point spread function main-lobe, as compared to the free interface case. At the same time side-lobes increase. For the dielectric interface, the reflections shape the singular values so that an increasing of the NDF is possible. However, now, this increasing depends on the dielectric jump (which dictates how fast the square of the reflection coefficient amplitude decreases) and on the possible regularizating threshold making the NDF noise dependent. For the parallel case, the reflection plane introduces a shaping on the singular values so that higher noise level can be accepted but the corresponding psf is not in general well "focused".