

INTEGRAL EQUATION METHODS FOR ACOUSTIC SCATTERING BY FRACTALS

ANDREA MOIOLA

Università di Pavia, Pavia, Italy

We study sound-soft time-harmonic acoustic scattering by general scatterers, including fractal scatterers, in 2D and 3D space. For an arbitrary compact scatterer we reformulate the Dirichlet boundary value problem for the Helmholtz equation as a first-kind integral equation (IE) involving the Newton potential. The IE is well-posed, except possibly at a countable set of frequencies, and reduces to existing single-layer boundary IEs when the scatterer is the boundary of a bounded Lipschitz open set, a screen, or a multi-screen. When the scatterer is uniformly of d -dimensional Hausdorff dimension in a sense we make precise (a d -set), the operator in our equation is an integral operator with respect to the d -dimensional Hausdorff measure, with kernel the Helmholtz fundamental solution, and we propose a piecewise-constant Galerkin discretization of the IE, which converges in the limit of vanishing mesh width. When the scatterer is the fractal attractor of an iterated function system of contracting similarities, we prove convergence rates, and describe a fully discrete implementation including quadrature rules for singular integrals on fractals. We present numerical results for a range of examples; our software is available as a Julia code.

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