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Analytical preconditioners for the solution of three-dimensional surface scattering problems

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The numerical solution of time-harmonic scattering problems remains challenging in the high frequency regime due to its specific computational bottlenecks. The techniques based on integral equations lead to the resolution of linear systems where the involved matrices are dense and usually badly conditioned. The improvement of these methods is a timely research area. One possibility to reduce the computational cost is to precondition iterative solvers (to speed up the convergence) and on the other hand to use fast methods to compute the matrix-vector products needed at each iteration.

We propose an analytical preconditioner taking inspiration of On-Surface Radiation Condition techniques. This preconditioner is an accurate approximation to the Dirichlet-to-Neumann map. The associated integral equations are of the second kind. Moreover, the proposed preconditioner shows highly desirable advantages: sparse structure, ease of implementation and low additional computational cost.

In this talk, we present first the principle of the method in the acoustic case. We show numerical simulations for various configurations. Next, we explain how to extend the approach to other types of waves, namely elastic waves (joint work with Stéphanie Chaillat et Frédérique Le Louër).

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