Hierarchical Bases for the Indefinite Helmholtz Equation

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For the indefinite Helmholtz equation, straight-forward multigrid solvers lose their efficiency and show slow convergence or even divergence for high wave numbers. An equally insufficient performance can be observed with a standard hierarchical basis approach.

The reason for this is that not all of the error frequencies can be treated by standard multigrid, especially those frequencies which are solutions of the homogenous equation can be totally invisible for the standard solvers because of their small residuals. Brandt and Livshits suggested an approach by introducing so-called ray cycles into their multigrid scheme which considered the irremovable errors as a superposition of plane waves. We adopt this approach by using a special hierarchical basis in which the piecewise linear basis functions are multiplied by wave functions with the appropiate wave length.

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