

# Detecting spurious solutions in Finite Element approximations of resonances in open systems

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## ABSTRACT

In time-harmonic scattering, the response field of a known penetrable obstacle is determined from an incident wave of given frequency. Usually, it is desirable to find the frequencies that give large amplitudes of the field. This question is closely related to resonance computations in open domains.

For this purpose, we use a Dirichlet to Neumann map (DtN) or a perfectly matched layer (PML) to reduce the problem to a bounded domain and approximate the resonances with a finite element method. The PML formulation is attractive since the dependence of the spectral parameter is linear. However, numerical examples indicate that for moderate matrix sizes the resolvent of the discrete problem is considerably large, which give rise to spurious eigenvalues. The DtN formulation is non-linear in the spectral parameter, but numerical computations show fewer spurious eigenvalues. However, since spurious solutions are present in both formulations the design of reliable methods for detecting true resonances is important. With this aim, we propose a new test based on the Lippmann-Schwinger equation. Numerical simulations indicate that the presented test can distinguish between spurious eigenvalues and true eigenvalues also in challenging cases.