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Resonant states completeness for models of the Helmholtz resonator

I.Y. Popov

ITMO University, St. Petersburg

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Fakulta jaderná a fyzikálně inženýrská ČVUT
Trojanova 13, 12000 Praha

Abstract: We deal with a model of the Helmholtz resonator, resonator with point-like boundary window. Lax-Phillips approach is used. Resonances (quasi-eigenvalues) are eigenvalues of some dissipated operator. The corresponding resonant states belong to $L_2(\Omega)$ for any bounded Ω . An interesting question appeared: What is the maximal domain Ω such that the resonant states are complete in $L_2(\Omega)$? The result is given by the following theorem.

Theorem. Let Ω^{in} be convex bounded domain in \mathbb{R}^3 , $-\Delta$ be the model operator corresponding to point-like window in the boundary. Then, the set of the resonant states of the operator $-\Delta$ forms a basis in $L_2(\Omega^{in})$.

A relation with Sz.-Nagy model is analyzed.

Corollary. Let a characteristic function S be the S-matrix for scattering by a convex obstacle with point-like window. Then S is the Blaschke (Blaschke-Potapov) product.

Decorated quantum graph (hybrid manifold) with two infinite leads is considered. Resonant states completeness is discussed.