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A numerical investigation of Jones Eigenmodes

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In this talk we introduce an unusual eigenvalue problem that arises in fluid-structure interaction problems: the Jones eigenmode problem, described first by D.S. Jones [1, 2]. Concretely, the Jones eigenvalue problem arises in the study of fluid-structure interaction problems where a bounded elastic body is immersed in an unbounded inviscid compressible fluid. Time-harmonic waves in the fluid are scattered by the elastic obstacle; the solution to this transmission problem is unique apart from certain frequencies, namely the Jones eigenvalues. At these frequencies, the elastic obstacle sustains time-harmonic displacements whose normal components as well as tractions are identically zero on the boundary, and the fluid-structure problem fails to possess unique solutions. In this unusual eigenvalue problem the existence of these eigenvalues intimately depends on the shape of the boundary; indeed, [3] proved that almost all domains with infinitely smooth boundary do not possess such modes. The situation for Lipschitz domains has not been deeply studied. In this paper we describe these eigenmodes for a range of planar domains. Analytic expressions are obtained for simple domains, and we confirm the existence of these modes for a range of other shapes numerically using a finite element strategy, as well as a spectral collocation approach.

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