Dynamic broadband cloaking of square inclusions

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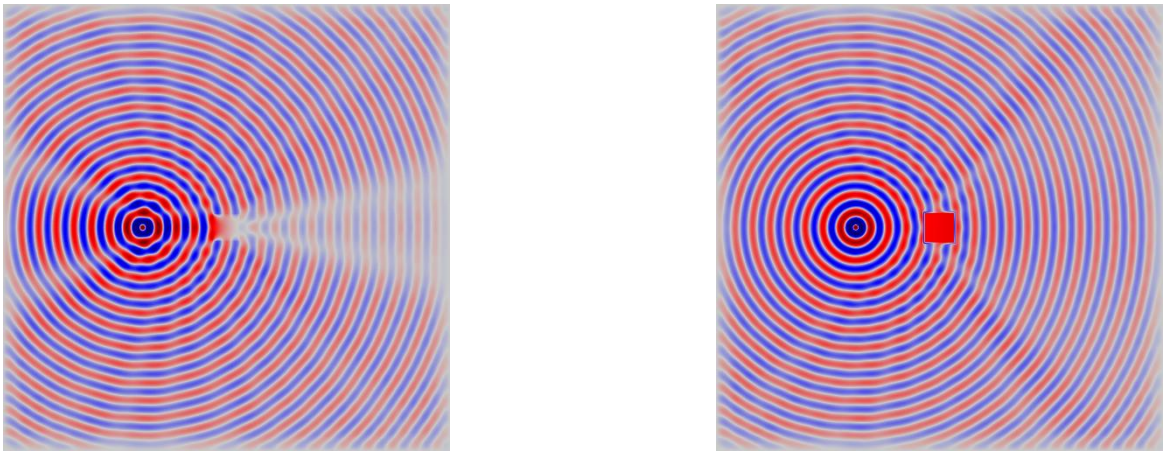
Abstract

Cloaking via transformation optics is a rapidly developing area of research allowing objects to be rendered invisible to certain classes of waves. However, the transformed material is often exotic and cannot be realised physically without introducing a complex micro-structure.

We present a relatively simple micro-structured cloak for a square inclusion. The micro-structure takes the form of a square lattice with massless links of uniform length and non-uniform stiffness, and the mass distributed non-uniformly throughout the lattice junctions. Analytical expressions for the stiffness tensor and scalar density are derived from a non-singular piecewise smooth continuum transformation in which the transformed material properties are finite, continuous, and piecewise smooth. This *"square push out"* transformation will be shown to possess significant advantages. The simple structure and material properties of the lattice cloak may enable such a cloak to be implemented in practice.

Analysis of the ray paths is presented and linked to the properties of the transformation, illustrating the effect of the cloak. Complementing the analytical work, numerical simulations illustrating the efficacy of the cloak are discussed. The effects of frequency, source position and type, and cloak thickness are examined. The microstructured cloak is refined by replacing the square lattice with a curvilinear, but locally orthogonal, discrete structure.



(a) Uncloaked Inclusion (b) Cloaked Inclusion

FIGURE 1: A comparison of the uncloaked inclusion (a) to the inclusion cloaked with the square lattice (b) for a point source.

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