Invisibility and Inverse Problems: Theoretical and Computational Approaches

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Abstract

In this dissertation, we discuss invisibility and inverse problems.

First, we discuss nonradiating orbital motions. We theoretically create nonradiating sources that orbit about the center of an annulus and are of whatever shape we want them to be. And we also discuss how one could possibly create an experimental setup demonstrating nonradiating orbital motions. The examples we discuss are all 2-D scalar wave problems.

Then, we discuss nonscattering scatterers. Building on the work of A. J. Devaney and others, we discuss about how to theoretically create objects that are invisible from some directions but not others. We find that, the more directions of invisibility our objects have, the harder they become to see when looking at them from between the object's directions of invisibility.

Finally, we discuss a globally convergent numerical method for solving a coefficient inverse problem. In particular, we discuss a Carleman-Picard iteration method for reconstructing the coefficient function for an inverse problem involving a parabolic PDE. The coefficient function can represent, among other things, a hidden object that we want to find without disturbing the medium in which our object is hidden. We demonstrate how well our new numerical method works with three tests.

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