Abstract

Reconstruction of the Microstructure of a Random Mixture

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In many heterogeneous materials such as porous media, biological materials, and artificial composites, the scale of microstructure is much smaller than the wavelength of the electromagnetic signal. In this situation, the wave cannot resolve all the details of the microstructure, and the response of the medium is homogenized. The talk discusses a problem of deriving information about the fine scale structure of a two component mixture from homogenized or effective measurements. The structural information is contained in the spectral measure in the Stieltjes representation of the effective complex permittivity. The spectral measure can be reconstructed from effective measurements. It is shown that the identification problem for the spectral function has unique solution, however the problem is extremely ill-posed. Several stabilization techniques are discussed such as quadratically constrained minimization, regularization using nonnegativity constraint, and reconstruction in the class of functions of bounded variation. The reconstructed spectral function can be used to estimate geometric parameters of the structure as well as to evaluate other effective properties of the same medium, such as effective thermal or hydraulic conductivity.