Abstract

Exact Solutions for the Dispersion Relation in a Wide Class of Periodic Media with Complex Moduli

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In the physics of heterogeneous periodic media it is rare to find exact solutions for the overall effective behavior. Here we will obtain exact solutions for the dispersion relation for a large class of materials with complex moduli. In media where the dependence of the dielectric (or viscoelastic) tensor is analytic in the spatial variable z and bounded in the upper half plane $\Im(z) > 0$ (so that apart from constants the real and imaginary parts are Hilbert transforms with respect to z of each other) we find that the three-dimensional Bloch equations are macroscopically equivalent to those in a medium where the moduli are averaged over z. This effectively reduces the problem to a two-dimensional one. Moreover if the average over z is independent of x and y, one has replaced the heterogeneous material by an equivalent homogeneous one. Alternatively, if the dielectric (or viscoelastic) tensor of this new medium has a similar analytic dependence on the spatial variable y, one is left with a one-dimensional to solve.

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