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Multiple scattering in random media by an integral equation approach – coherent fields

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The main aim of this paper is to calculate the coherent reflection and transmission characteristics of a finite or semi-infinite slab containing discrete, randomly distributed scatterers. Typical applications of the results are found at a wide range of frequencies (radar up to optics), such as attenuation of electromagnetic propagation in rain, fog, and clouds etc. In general, the non-intersecting scattering objects can be of arbitrary form, material and shape, and each scatterer is characterized by its transition matrix.
The integral representation of the solution of the deterministic problem and the translation properties of the spherical vector waves constitute the underlying framework of the stochastic problem. Conditional averaging and the employment of the Quasi Crystalline Approximation lead to a set of integral equations in the unknown expansion coefficients. Of special interest is the slab geometry, which implies an integral equation in the depth variable. Explicit solutions for tenuous media and low frequency approximations can be obtained for spherical obstacles.
A series of numerical simulation illustrates the results of the paper. Both reflection and transmission data are computed. The results are compared with the solution of the Radiative Transfer Equation and Beer-Lambert law. The small deviations and their consequences are discussed. The reflection results quantify the validity of the frequency range of homogenation.