PROPAGATION CONSTANTS OF COHERENT WAVES IN RADIATIVE TRANSFER THEORY AND IN WAVE THEORY

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It is popular to formulate and study scattering and propagation in random media using the phenomenological radiative transfer (RT) approach. One important quantity in the RT theory is the differential scattering cross section. The optical theorem then relates this quantity to the propagation constant of the coherent waves. On the other hand, in the wave approach we formulate the problem as a system of partial differential equations and boundary conditions for the Green's functions of the problem. On averaging this system we arrive at the Dyson equation, which may be solved using, for example, the bilocal approximation to the mass operator. The ability to solve this problem depends very much on the geometry under consideration. For the unbounded random medium with statistical homogeneity we can solve this equation and obtain closed form solution for the mean propagation constants. However, for bounded structures such as layered random media the problem is more complicated and it appears that we have to impose further approximations. It turns out that for the case of unbounded random medium the coherent propagation constants obtained by the RT approach and the wave approach are identical. However, in the case of layered media, we find that the expressions obtained are different. In the RT approach, the coherent propagation constants depend only on the statistical characteristics of the random medium. On the other hand, in the wave approach, the propagation constants depend not only on the statistical characteristics of the medium but also on the boundary reflection coefficients and the thickness of the layer. As a consequence we find that in the RT approach, the propagation constants depend on polarization only if the spectral density of the random medium and/or the medium itself is anisotropic. But in the wave approach we find that the propagation constants depend on polarization even if the medium and the spectral density are isotropic. The anisotropy is this case is due to the layer geometry. This leads to considerable complication in subsequent analysis and in the calculation of field covariances. Thus it is important to know about the significance of the influence of the layer geometry on the coherent propagation constants. If it turns out that in the problem under study the influence of layer geometry on the propagation constants is not significant the subsequent analysis and indeed the equation for field covariance are considerably simplified. We consider some numerical examples to assess the propagation characteristics in a random medium layer and their dependence on the layer geometry. We find that, in general, the effects of boundaries on propagation constants are not significant in most situations encountered in applications.

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