Near Fields in Electromagnetic Wave Multiple Scattering in Random Media

Y. N. Barabanenkov and M. Y. Barabanenkov
Russian Academy of Sciences, Russia

Usually the near fields are not taken into account in study the electromagnetic wave multiple scattering in random media. Nevertheless their effects may be substantial, as it is shown in this report, even in such coherent phenomena as weak localization of waves in random media. Besides a contribution of near fields may be strong dependent on the shape of random medium inhomogeneity. One should note that consistent consideration the near fields effects became possible after a modern development of the wave multiple scattering theory in terms of Sommerfeld-Weyl angular-spectrum decomposition of wave amplitudes, transfer relations [1] and extended unitarity for 2×2 block S-scattering matrix [2], with accounting for energy transformation between propagating and evanescent waves at scattering by dielectric structures.

We start with a system of equations for angular spectral amplitudes of local monochromatic field waves going forward and backward with respect to an embedding parameter into the 3D random medium slab with given boundary conditions on the slab boundaries. We write also the Liouville type equation for 2×2 block density matrix of angular spectral amplitudes. This Liouvile equation possesses a specific energy invariant (pseudo-trace of density matrix), with respect to the embedding parameter. Applying the Furutsu-Dosker-Novikov formalism [3], we obtain the Dyson type equation in Bourret approximation for ensemble averaged angular spectral amplitudes and the transfer equation for 2×2 block coherence matrix. The Dyson equation is simple resolved, with result showing a strong dependence of evanescent wave contribution into coherent reflectance from slab on shape of dielectric permittivity correlation function. The transfer equation is transformed to integral form which can be resolved by iteration procedure. Every term of this procedure includes, in particular, products of opposite going waves' spectral amplitudes which may be propagating or evanescent, that gives a possibility to evaluate a relative contribution of evanescent waves into the coherent backscattering of waves and the influence of evanescent waves on coherent backscattering cone width and on reducing of the random medium depth where the coherent backscattering is actually formed.

REFERENCES

1. Barabanenkov, Y. N., V. L. Kouznetsov, and M. Y. Barabanenkov, *Progress in Electromagnetic Research, PIER*, ed. Kong, J. A., EMW, Cambridge, England, Vol. 24, 39–75, 1999.
2. Gulyaev, Y. V., Y. N. Barabanenkov, M. Y. Barabanenkov, and S. A. Nikitov, *Phys. Rev. E*, Vol. 72, 026602-1-026602-12, 2005.
3. Rytov, S. M., Y. A. Kravtsov, and V. I. Tatarskii, *Principles of Statistical Radiophisics*, Vol. 3, *Wave Propagation through Random Media*, Springer, Berlin, 1989.