Analytic Multiple Scattering Theory for Bicontinuous Random Medium

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Modeling the wave propagation and scattering in random medium benefits a lot for microwave remote sensing. Snow is a typical random media in nature which is important in hydrology, climatology and meteorology. The bicontinuous model is one of ways to generate computer snow. Traditionally simulations for bicontinuous medium is conducted by the numerical solutions of Maxwell equations in 3-dimensions (NMM3D) based on discrete-dipole approximation (DDA), which is time and memory consuming (K.-H. Ding, IEEE Trans. Geosci. Remote Sens., 8, 3139-3151, 2010). Analytically the strong permittivity fluctuations (SPF) is utilized for random medium with large variance of permittivity distribution by properly dealing with the singularity of dyadic Green's function. With bilocal approximation of Dyson's equation and low frequency limit, the effective permittivity of both isotropic and anisotropic random medium is calculated with SPF (L. Tsang and J. A. Kong, Radio Sci., 3, 303–320, 1981). Recently, an approach to generate anisotropic bicontinuous medium is proposed. Both NMM3D and SPF were used to calculate the anisotropic effective permittivity of bicontinuous medium (S. Tan, IEEE Geosci. and Remote Sens. Letters, 13(8), 1168-1172, 2015). Based on contributions from these works, SPF is already indicated as a good method to model the wave propagation of random medium once the correlation function of the medium is known.

In this paper, we go one step further to calculate not only effective permittivity but also scattering properties of bicontinuous medium using SPF. With the correlation function of bicontinuous medium, SPF theory is applied to calculate the effective permittivity. Furthermore, based on the distorted Born approximation, scattering properties (extinction coefficient, scattering field and coefficient etc.) of bicontinuous medium are also calculated. SPF theory gives analytical solutions for bicontinuous medium. The results of SPF are compared with results of NMM3D to show its effectiveness. In order to improve the accuracy of SPF, the low-frequency limit is also eliminated and higher order approximation of Dyson's equation is introduced.