Electromagnetic scattering by dense discrete random media: Numerical solution via radiative transfer with reciprocal transactions R2T2

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Electromagnetic scattering in a macroscopic particulate medium composed of densely-packed microscopic particles constitutes an open computational problem, resulting in the absence of quantitative inverse methods to interpret various spectroscopic, photometric, and polarimetric remote sensing observations.

We present our extended numerical method of the radiative transfer and coherent backscattering (RT-CB) for dense discrete random media entitled R2T2 (K. Muinonen et al., Radio Science, submitted, 2017). In this approach, we utilize the ensemble-average incoherent extinction, scattering, and absorption properties of a volume element allowing us to remove shortcomings due to the assumption of independent scattering in a sparse random medium. The order-of-scattering interactions among the volume elements are computed exactly using the superposition T-matrix method STMM. The STMM, in turn, employs an efficient volume-integral-equation VIE approach to compute the T-matrices of individual particles and the fast multipole method to accelerate the superposition T-matrix solution (J. Markkanen and A. J. Yuffa, JQSRT 189, 2017). Further, we present an approximate technique derived from the R2T2 that reduces the required computational resources from a supercomputer to a desktop without deteriorating the accuracy of the method significantly.

In our method, the size of the random medium can range from microscopic to macroscopic sizes, whereas the particles are assumed to be of the order of the wavelength in size. We compare the results of the new method to the standard RT-CB and the full wave results computed by the STMM.

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