A Semi-rigorous Method for Scattering from 2D Rough Heterogeneous Surfaces

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Scattering from three-dimensional rough heterogeneous media is a challenging problem that can hardly be addressed by the classical numerical methods (FDTD, Coupled-Dipole Approximation, ...) due to the cost of computing over a large three-dimensional domain.

We propose an efficient numerical method to calculate scattering from two-dimensional rough surfaces on top of an assembly of random inclusions. The roughness has large scales compared to radiation wavelength and the scatterers are small particles that radiate like dipoles.

Our approach is semi-rigorous as multiple scattering between particles and between surface and scatterers are accounted for. The Kirchhoff Approximation (KA), however, is used to compute the electric and magnetic currents produced at the interface.

In the KA, the surface currents depend only on the local incident field on the surface, which is the sum of the incident beam and fields scattered by all the particles. The latter are the dipolar response of each particle excited by both the field radiated by the surface currents and the field steeming from the other particles. All these interactions are expressed trough operations on the (unknown) dipolar moments of the scatterers. Finding these dipolar moments then amounts to solve a linear system of size 3N, N being the number of scatterers.

Once this is done, surface currents can be made explicit, as well as the field scattered above by the heterogeneous surface.

Some numerical test cases will be presented. A cross-comparison with other methods will be made on simple geometries to validate the results.