T-matrix simulations of light scattering by densely packed nonspherical particles

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Combining the T-matrix method with the translation addition theorem for spherical vector wave functions (SVWFs), the superposition T-matrix method (STMM) [1, 2] offers excellent solutions to multiple-scattering problems, when light scattering by large ensembles of spherical particles or sparsely distributed nonspherical particles are considered. In fact, the STMM requires that adjacent particles' circumscribing spheres not intersect [3]. Hence, it is not suitable for clusters formed by densely packed nonspherical particles.

In this communication, we discuss an alternative formulation of the translation operator for SVWFs based on a plane wave expansion (PWE) [4]. In contrast to a spherical wave expansion (SWE), which is valid everywhere outside a particle's circumscribing sphere, a PWE can express the correct scattered electromagnetic field everywhere below or above a bounding plane of a particle. This holds true, even if it is constructed from the SWE [5]. Hereby the PWE enables to couple scattered fields of adjacent particles in close vicinity. The plane wave coupling formalism is integrated into the conventional superposition T-matrix scheme, allowing its utilization in large particle systems, whenever its use is necessary.

We demonstrate the suitability of our approach by comparing it to finite element method simulations of densely packed systems of arbitrary oriented, high aspect ratio particles. Finally, we discuss the method's suitability for far- and nearfield computations, for both dielectric and metallic particles of convex surface shape.

References

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