Light scattering by collections of metallic spheroids

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Light scattering by nonspherical metallic nanoparticles supporting plasmon resonances is a cornerstone of surface-enhanced spectroscopies, but remains a challenging system to model theoretically. Over the last several years we have extended the Extended Boundary-Condition Method for the specific case of spheroidal particles, as for this particular shape the *T*-matrix elements have unique numerical properties [1,2]. These investigations have resulted in an efficient and accurate numerical implementation for single spheroids [3], which enables benchmark calculations of far-field and near-field properties for a wide range of parameters. In particular, we used this method to demonstrate numerically the limits of the Rayleigh hypothesis, where the multipolar series expansion of the scattered field may fail to converge in the vicinity of the particle [4].

Where light interacts with a collection of particles in relative proximity, multiple scattering effects can substantially affect the optical response. With the individual *T*-matrix of each scatterer already available, the superposition *T*-matrix framework is an appealing approach to describe the collective response of a cluster of such particles [5,6]. We have implemented several algorithms from the literature and compared their performance in the challenging case of light scattering by metallic spheroids. This contribution will present our results for different geometries of particle clusters, and notably discuss the convergence properties of far-field cross-sections and near fields when metallic spheroidal particles are placed such that their smallest circumscribing spheres intersect.

References

[1] Somerville, W. R. C., B. Auguié, and E. C. Le Ru, 2012: Severe loss of precision in calculations of *T*-matrix integrals. *J. Quant. Spectrosc. Radiat. Transfer* **113**, 524–535.
[2] Somerville, W. R. C., B. Auguié, and E. C. Le Ru, 2015: Accurate and convergent T-matrix calculations of light scattering by spheroids. *J. Quant. Spectrosc. Radiat. Transfer* **160**, 29–35.
[3] Somerville, W. R. C., B. Auguié, and E. C. Le Ru, 2016: SMARTIES: User-friendly codes for fast and accurate calculations of light scattering by spheroids. *J. Quant. Spectrosc. Radiat. Transfer* **174**, 39–55.
[4] Auguié, B., W. R. C. Somerville, S. Roache, and E. C. Le Ru, 2016: Numerical investigation of the Rayleigh hypothesis for electromagnetic scattering by a particle. *J. Opt.* **18**, 075007.
[5] Mackowski, D. W., and M. I. Mishchenko, 1996: Calculation of the *T* matrix and the scattering matrix for ensembles of spheres. *J. Opt. Soc. Am. A* **13**, 2266–2278.
[6] Stout, B., J. C. Auger, and A. Devilez, 2008: Recursive *T* matrix algorithm for resonant multiple scattering: applications to localized plasmon excitations. *J. Opt. Soc. Am. A* **25**, 2549–2557.

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