How can the discrete dipole approximation reproduce morphology-dependent resonances of spheres?

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During the development and application of a scattering algorithm, its accuracy is normally validated by comparing with the results for spherical particles given by the exact Lorenz–Mie theory. The morphology-dependent resonances (MDRs) show significant influences on the scattering properties of particles within sufficiently narrow size ranges [1–3], and may affect the validation of the numerical models. It is unclear whether numerical models that solve Maxwell's equations by discretizing the space could reproduce the MDRs of spheres. This presentation investigates the performance of the Discrete Dipole Approximation (DDA) on modeling the scattering properties with the MDRs. Our results indicate that the DDA can capture both the peak position and peak value in the extinction efficiency over the size parameter caused by an MDR only if an extremely fine discretization is used. To be more specific, the dipole size has to have size similar to the width of the MDRs to produce the accurate MDR results. However, the extinction curves simulated by the DDA (even at relatively coarse discretization) can be fitted with a Lorentzian as well as Lorenz–Mie results [4]. Moreover, the convergence of the corresponding peak parameters with refining discretization is relatively smooth, which allows using Richardson extrapolation (to zero dipole size) to accurately restore the reference Mie values.

References

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