

# Light scattering by nonspherical particles: Application to coccoliths detached from Emiliania huxleyi

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ABSTRACT: Computation of the light scattering properties of marine particles has typically been effected using Mie theory (i.e., modeling the particles as homogeneous or layered spheres). Because scattering by irregularly shaped particles is significantly different from that of spheres, particularly in backscattering directions, it is of interest to examine the efficacy of using more complex formulations of light scattering that are not limited to spherically symmetric particles. We applied the discrete dipole approximation (DDA) to the computation of the scattering properties of detached calcium carbonate coccoliths from the coccolithophorid *Emiliania huxleyi*. Three distinct models of *E. huxleyi* coccoliths were studied: thin disks with a diameter of approximately 2.75 μm, washers with a 1.38- μm hole in the disk, and two parallel disks joined by a hollow tube (a "fishing reel"). The model coccoliths all had the same volume (mass ~ 0.19 pg carbon) and disk diameter and a refractive index of 1.20 relative to water. DDA computations for randomly oriented model coccoliths showed that the total scattering cross section and its spectral variation are similar for each of the three particle shapes and agree well with measurements made in natural *E. huxleyi* blooms both on a per-coccolith and per-calcite concentration basis. The backscattering cross section and its spectral variation was found to be strongly dependent on particle morphology. This dependence was shown to be due to multiple reflections within the particle. Scattering and backscattering coefficients for volume-equivalent spheres were within a factor of two of those for the disklike models.