Mie Scattering of Electromagnetic Waves

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Abstract

Scattering of electromagnetic waves by spherical particles is described by the Mie solution to Maxwell's equations. Illumination of an obstacle by an electromagnetic wave excites electric charges in the obstacle to oscillate due to interaction with the electric field of the incident wave. The oscillating charge radiates electromagnetic energy in all directions; this secondary radiation that is the radiation scattered by the obstacle. In addition, the excited elementary charges may absorb radiation and transform part of the incident energy into other forms, such as thermal energy. Both scattering and absorption remove energy from a beam of light and the beam is attenuated. For particles much larger or much smaller than the wavelength of the scattered light approximations exist to describe the behavior of the system, for objects whose size is similar to the wavelength a more exact approach is required.

In this work, Mie scattering of an incident electromagnetic wave by a spherical particle has been analyzed using COMSOL Multiphysics®. The nature of the interaction has been considered for materials with three different properties: metallic, magnetic and dielectric. The solutions provide details of the absorption, scattering, extinction, pressure cross-sections, back-scattering and radiation force exerted on the particle by an incident plane wave.Results of these analyses are compared against available analytical solutions.