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Electromagnetic Scattering by Ag and Au Spheres

Fangcheng Huang(1), Fabio Mangini(1)(2), Sidra Batool(1), Remo Proietti Zaccaria*(3), Fabrizio Frezza*(1)
(1) Department of Information Engineering, Electronics, and Telecommunications, La Sapienza University of Rome, Via Eudossiana 18, 00184 Roma, Italy
(2) University of Brescia, Department of Information Engineering (DII), via Branze 38, 25123, Brescia, Italy
(3) Istituto Italiano di Tecnologia via Morego 30, 16163, Genova, Italy

The scattering and absorption of light by small particles is a fundamental issue in electromagnetic (EM) theory, which applied in surface plasmonics, Surface Enhanced Raman Scattering (SERS), Optical Tweezers (OT). Gold and silver nanostructures are the most frequently used metals in either nanoscience or nanotechnology. In order to get the suitable models, the authors compare the Lorentz-Drude (LD) model, the Double Critical Points (DCP) model, and the total physical model from 200nm∼1000nm. We have selected the DCP model as the dielectric function. Give the new method to calculate the spherical Bessel function which can calculate the BF with small and complex parameter. Later, base on the Rayleigh and Mie scattering theory, the authors compare the EM scattering problem with Comsol, getting the scattering cross section (SCS) and absorption cross section (ACS) coefficients, the E-field inside and outside the sphere. We have used primer factorial method to calculate the Winger-3j function, calculate the Gaunt coefficients for the single sphere scattering. Base on the recurrence relations for the three-Dimension scalar and vector addition theorem, the authors calculate the element of the scalar and the vector translation matrix. After this, give the detail about the T-matrix. This allows us to find the E-field of a random incident wave for the scattered field. We have deeply investigated the extended Mie theory, give the T matrix of multi-sphere scattering, and compare it with the recurrence method. At last we developed the c++ code of multi-sphere EM scattering with plane incident wave.

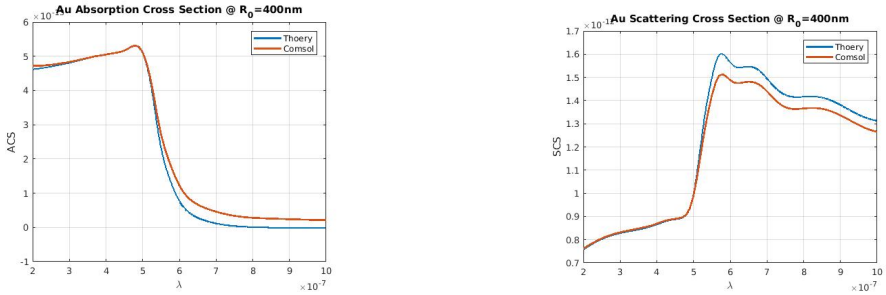

Figure 1. Single Au absorption cross section and scattering cross section with R=400nm, use LD model, Mie theory and compare it with comsol simulation.

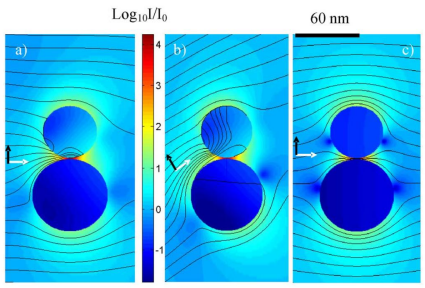

Figure 2. Local intensity distribution I/I0 in logarithmic scale and the streams of EM energy (solid lines) in the plane of the wave vector k (the white arrow) and the electric field E (the black arrow) through the centers of an Au sphere (upper) with radius 25 nm and an Ag sphere (lower) with radius 35 nm at the incident wavelength 514.5 nm for (a) and (b), and 800 nm for (c). k is perpendicular to the axis of the two spheres in (a) and (c). In (b), k and the axis of the two spheres have an angle of 60. The surface separation between the two spheres is 1 nm

References

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[2] Xu Hong-Xing, "A new method by extending Mie theory to calculate local field in outside/inside of aggregates of arbitrary spheres," *Physics Letters A*, 2003, doi: 10.1016/S0375-9601(03)00687-X.