Humblet's angular momentum decomposition applied to terahertz radiation torque on metallic spheres in the Hagen–Rubens approximation

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When circularly polarized light is scattered by isotropic spheres, Humblet's decomposition [1] is helpful for understanding why the axial projection of "spin-related" scattered angular momentum transport gives incomplete information concerning the total radiated angular momentum [2,3]. Some of the radiated angular momentum is found to be "orbital-related." This application of Mie scattering gives insight into why classical electromagnetic radiation torques are proportional to absorbed power for isotropic spheres [4]. It also reveals the direct measurability (from Stokes parameters) of the contributions to the radiated angular momentum. The relative angular momentum components [2,3] were also derived by others [5] and applied to dielectric spheres.

This talk considers metallic spheres illuminated by circularly polarized light modeled with Mie theory in the Hagen–Rubens approximation (HRA) in which the real and imaginary components of the sphere's refractive index are equal in magnitude [6]. (The HRA was anticipated by Maxwell's suggestion to neglect displacement currents to give a diffusion equation for the vector potential in metals. It is useful for some non-magnetic metals for terahertz and lower frequencies provided the Drude collision rate and plasma frequency are sufficiently large.) It was found helpful to compare the "spin efficiency factor" Q_{spin} introduced in [2,3] with the canonical scattering efficiency factor Q_{sca} for varying sphere sizes at a fixed frequency. A small-size limiting case [2,3] is recovered while novel structure for larger sizes is revealed. The limiting case for small sizes is associated with a common classical interpretation of dipole-related torque [2,4].

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References

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