Generalized Lorenz-Mie Theory for the Arbitrarily Oriented Shaped Beam Scattering by a Spheroid

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Light scattering by a spheroid was firstly studied by S. Asano, et al., [1]. It was extended to the case of arbitrary shaped beam scattering by J.P. Barton [2], who described the incident field through "surface integrals". Within the framework of generalized Lorenz-Mie theory (GLMT) [3], on-axis and off-axis Gaussian beam scattering by a spheroid was also studied by Han, et al., [4, 5].

In the present paper, the scattering of a shaped beam with arbitrary orientation relative to a spheroidal particle is developed within the framework of GLMT, i. e., the arbitrarily oriented incident beam is firstly expressed by the beam shape coefficients (BSC) in spherical coordinates. Then the BSC is transformed to the spheroidal coordinates, thanks to the relationship between the spherical wave vectors ($\mathbf{m}_{mn}$, $\mathbf{n}_{mn}$) [6] and the spheroidal ones ($\mathbf{M}_{mn}$, $\mathbf{N}_{mn}$) [7].

But we found that for BSC evaluation by the localization approximation is no longer valid for the oblique incidence. So the quadrature method is applied instead. Besides, for the sake of consistence with Lorenz-Mie theory, time dependence of $\exp(i\omega t)$ is used, instead of $\exp(-i\omega t)$ in GLMT. The relationship of the BSC in two different time conventions are carefully examined and a simple relationship is found.

Finally, numerical results of the scattered intensity in far field are presented. They are found coincident with those in the cases of both oblique plane wave incidence on a spheroid [1] and shaped beam incidence on a sphere [3].

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