Internal and near-surface fields of a *charged* sphere illuminated by a vector Bessel beam

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Vector vortex beams (VVBs) [1] have recently attracted increasing interest for various applications including super-resolution imaging, on-chip switching, optical tweezers [2], and so on. It is worth mentioning that a VVB may carry both phase singularity and polarization singularity. Many researchers have studied the singularities (optical vortices) carried by VVBs, and a new branch of physics name singular optics [3,4] is formed. Most the applications involve the interaction of VVBs with particles, which can be rigorously solved using generalized Lorenz–Mie theory [5]. However, it gives few clues to the various physical processes that are responsible for the scattering. To isolate the contribution of various scattering process and to further investigate the physical origins of many effects that occur in scattering, the internal and scattering coefficients can be rewritten in terms of Debye series expansion (DSE) [6–9].

The aim of this paper is to discuss the internal and near-surface fields of a *charged* sphere illuminated by a vector Bessel beam using DSE. The internal and scattered coefficients for a charged sphere are first expanded using DSE, and the beam shape coefficients (BSCs) of a VVB are derived using the angular spectrum decomposition and the multipole expansion of spherical harmonic functions. The internal and near-surface fields of a charged sphere illuminated by a VVB are numerically computed. The effects of the carried charges, the order, polarization, and half-cone angle of the beams are discussed. The internal fields for various scattering processes (namely Debye mode *p*) are analyzed. Potential applications of these results include particle sizing, optical trapping and manipulation, etc.

References

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