Electrostatic properties of porcupic and bulbic spheroids

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This contribution describes the effect of geometric and material properties on the electrostatic scattering from a spheroidal object. The object is assumed to be anisotropic in a way that aligns the axis of anisotropy with the unit vectors of the spheroidal coordinate system. It is further assumed that the object is immersed in a homogeneous background medium, which is permeated by a uniform and static electric field.

The scattering properties of the object are perused by analytic means. The magnitude of the scattering is quantified in terms of normalized polarizability. In general, the normalized polarizability depends on the orientation of the excitation field. Four closed form equations suffice to provide the general normalized polarizability of an arbitrary radially anisotropic spheroid. These equations correspond to the two types of spheroidal objects, oblate and prolate, and the two orientations of the excitation field, one parallel to the axis of symmetry and the other perpendicular.

This contribution gives particular attention to the effect of different types of anisotropy on the scattering properties of the object. The anisotropy is classified in two categories, *bulbic* and *porcupic*, where the term “bulbic” refers to an object with a predominant tangential component of the permittivity and the term “porcupic” refers to an object with a predominant normal component of the permittivity. The term “bulbic” is an allusion to an onion whereas the term “porcupic” is an allusion to a porcupine.

The normalized polarizability of the anisotropic object can be illustrated graphically in a diagram where the polarizability changes as a function of a varying axis ratio of the spheroid. This graphical representation reveals a qualitative difference between bulbic and porcupic objects. When the excitation field is parallel to the axis of symmetry, porcupic scatterers exhibit a non-monotonic dependence of polarizability over the axis-ratio but the bulbic ones do not. In case of perpendicular excitation, however, it is the bulbic type that exhibits the non-monotonic dependence.