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On peculiarity of spheroids

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Spheroids are the most often used shape of non-spherical particles in the light scattering theory. They are frequently treated by the methods based on field expansions in the spherical wave functions. Applicability of such approach was considered in the analytical and numerical ways with controversial results: calculations demonstrate serious problems for spheroids with the aspect ratio above $\sim$5–10 (the use of extended precision reduces the problems but does not remove them), while theories either say that the approach should have no limits or conclude that singularities of the wave fields require inapplicability of the approach to spheroids, e.g., with $a/b > \sqrt{2}$.

We use the electrostatic case which is much simpler but still principally similar to the light scattering one to find the real theoretical range of applicability of the methods like EBCM or SVM with a spherical basis when applied to homogeneous and layered spheroidal particles. First, we note that spheroids are peculiar particles as for them and only for them the internal field is uniform in the electrostatic case. We suggest another prove that there are no other particles with the uniform internal field. It is a virtual character of the internal field singularities for spheroids that gave rise to the difference of theoretical conclusions – for homogenous spheroids these singularities are shown to be virtual as the field is uniform while for layered spheroids they become real. Our understanding is confirmed by consideration of spheroids with a confocal envelope where we performed calculations with unlimited precision to investigate numerically the convergence range which is found to be as follows: $a/b < 1 + \sqrt{2}$. Finally, we show how our results allow one to reach agreement of theoretical and numerical studies of EBCM and SVM applicability to spheroids and other non-spherical scatterers.