On the helicity conservation: Detection of brand-new dipolar regimes

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In this Letter we demonstrate that the conservation of the electromagnetic (EM) helicity, signature of the EM duality restoration, can be used as a probe of single-polar spectral regions, particularly, electric and magnetic dipolar regimes. Our proof is solely based on a fundamental mathematical property of the Bessel functions that precludes the zero optical condition in a multipolar scattering process. Interestingly, we derive that the optimum forward light scattering, predicted for a diamond sphere, presents an infinite number of solutions for a fixed x size parameter, in striking contrast to previous findings.

Figure

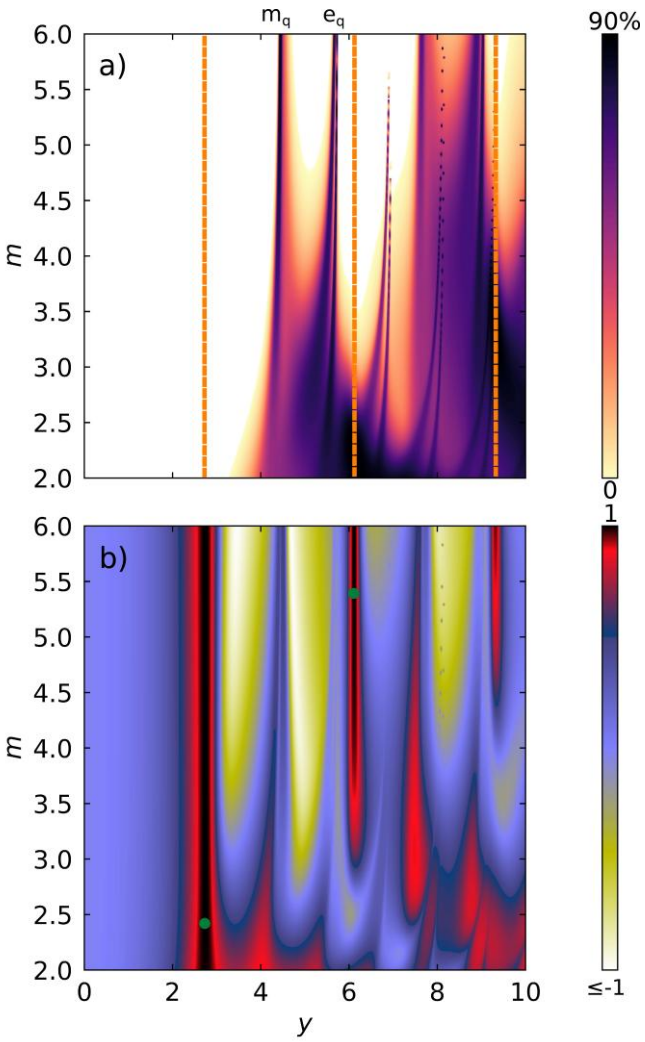

Figure 1: (a) Percentage error of presuming a dipolar response versus the y = mx size parameter and contrast index m. The validity of assuming a dipolar regime, corresponding to the white region, extends beyond the magnetic and electric quadrupole for certain spectral regions. The first Kerker condition is as well illustrated for completeness by vertical dashed orange lines. (b) Color map of the expected value of the EM helicity after scattering by a Mie sphere under well-defined EM helicity plane wave illumination. As it is depicted in the attached color-bar, the EM helicity is preserved in the dipolar regime. The green circles illustrate two different materials fulfilling the optimum backward light scattering condition.