On the electromagnetic scattering by magnetodielectric small spherical particles

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Abstract- We analyze the light scattering by a magnetodielectric subwavelength isolated sphere and its capacity to show non-usual scattering properties, like the inhibition of backward scattered intensity and the almost inhibition of the scattered intensity in the forward direction. The possible relevance of this study in micro and nano- technological fields will be presented.

Magnetodielectric small spheres present unusual electromagnetic scattering features, theoretically predicted a few decades ago by Kerker et al. [1]. However, achieving such behavior has remained elusive, due to the non-magnetic character of natural optical materials or the difficulty in obtaining low-loss highly permeable magnetic materials in the gigahertz regime. Here we present unambiguous experimental evidence that a single low-loss dielectric subwavelength sphere of moderate refractive index ($n \approx 4$ like some semiconductors (Si, Ge) at near-infrared) radiates fields identical to those from equal amplitude crossed electric and magnetic dipoles, and indistinguishable from those of ideal magnetodielectric spheres. The measured far-field scattering radiation patterns (see Fig. 1(a)) and degree of linear polarization (3–9 GHz/33–100mm range) show that, by appropriately tuning the a/λ ratio, zero-backward ('Huygens' source) or almost zero-forward ('Huygens' reflector) radiated power can be obtained [2]. Also, the near-field scattering distributions and their correlation with those measured in far-field, are numerically calculated and analyzed (see Fig. 1(b)). These Kerker scattering conditions [1] only depend on a/λ. Our results open new technological challenges from nano and micro-photonics to science and engineering of antennas, metamaterials and electromagnetic devices.

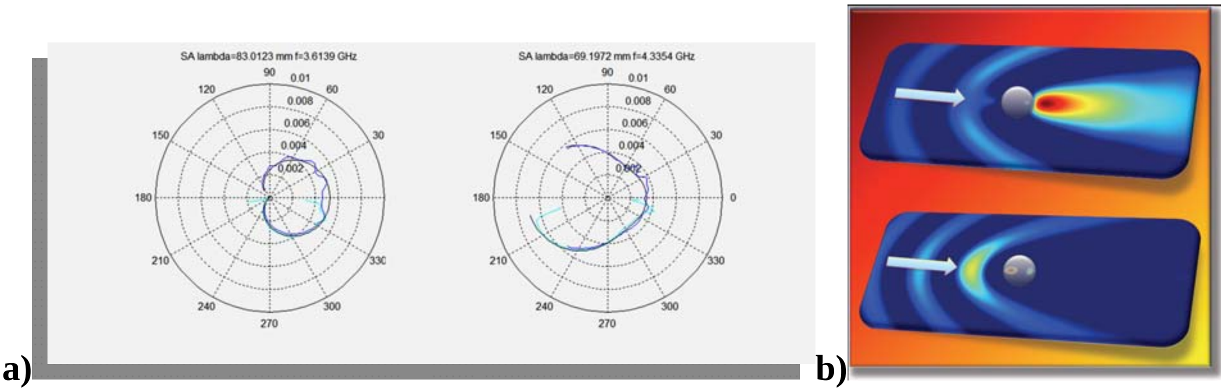

Figure 1- (a) Far-Field (experiment (blue line), theory (black line)) and (b) Near field intensity distributions of a subwavelength dielectric sphere (refractive index$\approx$4+0i), illuminated by a linearly polarized monochromatic wave (white arrow), for the two Kerker frequencies: Zero-backward: 3.6GHz (left in (a), top in (b)) and near zero-forward: 4.3GHz (right in (a), bottom in (b)).

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