R. Gómez-Medina[1], L. S. Froufe-Pérez[2], M. Yépez1, F. Scheffold[3], M. Nieto-Vesperinas[4] and J.J. Sáenz[1]

[1]Condensed Matter Physics Dept. and Centro de Investigación en Física de la Materia Condensada (IFIMAC), Universidad Autónoma de Madrid, Madrid, Spain
[2]Instituto de Estructura de la Materia, Consejo Superior de Investigaciones Científicas CSIC, Madrid, Spain
[3]Department of Physics, University of Fribourg, Fribourg, Switzerland
[4]Instituto de Ciencia de Materiales de Madrid, Consejo Superior de Investigaciones Científicas (CSIC), Madrid, Spain

r.gomezmedina@uam.es

Negative scattering asymmetry parameter for dipolar particles: Unusual reduction of the transport mean free path and radiation pressure

Propagation of light and image formation in turbid media has long been a subject of great interest [1] and constitutes the core of powerful techniques with countless applications including biomedical imaging [2, 3] and dynamic spectroscopy techniques [4-6], characterization of composite materials and complex fluids [7], remote sensing or telecommunications [8] to mention a few.

Lossless dielectric nanospheres (made of nonmagnetic materials) with relatively low refraction index may present strong electric and magnetic dipolar resonances [9-11].

We establish a relationship between the optical force [12,13] from a plane wave on small electric and magnetic dipolar particles, the transport cross section, and the scattering asymmetry parameter g [14].

In this way we predict negative g (that minimize the transport mean free path below values of the scattering mean free path) for a dilute suspension of both perfectly reflecting spheres as well as of lossless dielectric nanospheres made of moderate permittivity materials, e.g., silicon or germanium nanospheres in the infrared region. Lossless dielectric Mie spheres of relatively low refraction index (as low as 2.2) are shown to present negative g in specific spectral ranges [14].

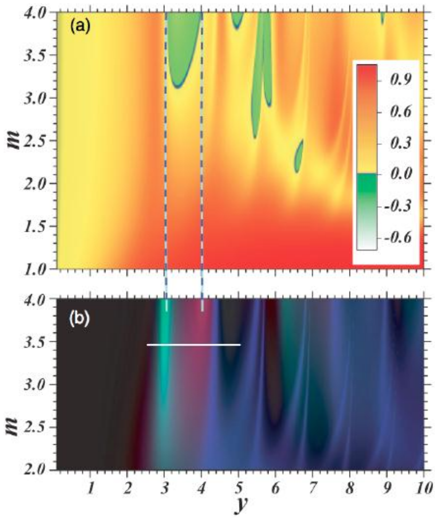

Figure 1: (a) Color map of the g factor for spherical absorptionless particles as a function of their refractive index m and size parameter y = mka. As seen in the attached scale, green areas correspond to negative values of g. (b) Color map of the sphere scattering cross section. Red corresponds to dominant electric dipole contributions to the scattering cross section. Green corresponds to dominant magnetic dipole contributions, while blue sums up all higher-order multipole terms. Vertical dashed lines coincide with y parameter for maximum electric dipole contribution (right vertical line) and maximum magnetic dipole contribution (left vertical line). The white horizontal line at m ≈ 3.5 which corresponds to a silicon sphere. (After Ref.[14]).

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