**Radiative corrections to the polarizability tensor of an electrically small anisotropic dielectric particle**

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Electromagnetic scattering from nanometer-scale objects has long been a topic of large interest and relevance to fields from astrophysics or meteorology to biophysics and material science [1]. During the last decade nano-optics has developed itself as a very active field within the nanotechnology community. Much of it has to do with plasmon (propagating) based subwavelength optics and applications [2]. Also, isolated metallic particles supporting localized plasmons have attracted a great deal of interest due to their ability to concentrate the electromagnetic field in subwavelength (some tens of nanometers) volumes. As a result, the studies in the field often involve the contributions of small elements or particles where the dipole approximation may be sufficient to describe the optical response. Examples of applications are on telecommunications [3], spontaneous emission rates and fluorescence [4], sensors [5], energy harvesting [6], optical forces and trapping [7] or medical therapy [8]. The capabilities and applicability of all these promising examples can be largely enhanced if some degree of tunability is added. These capacities can be endorsed by exploiting different x-optic effect (thermo-, electro-, magneto-, piezo-) where an external agent modifies some elements of the dielectric tensor, ε , in some extent [9] which, in general, will be non-diagonal. Most of the previous works on small anisotropic spherical particles, consider the dipolar approximation (DA) in the electrostatic limit [10]. By taking into account the fact that the polarization within the sphere is uniform, the polarizability is usually written as

$$\alpha_0 \equiv 3v\left(\varepsilon - \varepsilon_h \overleftrightarrow{I}\right)\left(\varepsilon + 2\varepsilon_h \overleftrightarrow{I}\right)^{-1} \qquad (1)$$

being $v=4\pi a^3/3$ the particle and $\varepsilon_h$ the relative permittivity of the host medium at the point where the particle is placed. The host medium is assumed to be isotropic. Different extensions, including anisotropic and bianisotropic nonspherical particles, have been considered in the literature.

However, in most of the cases, the energy balance between absorption and scattering has not been considered. In particular, in absence of absorption, the polarizability tensor given by Eq. (1) does not fulfill the Optical Theorem. For isotropic particles (where the polarizability is a scalar quantity), radiative corrections to the electrostatic polarizability [1] solve the problem of energy conservation in absence of absorption. Even in the case of absorbing particles, extended radiative corrections have been shown to be relevant to determine the effective permittivity of metallic nanoparticle doped composites. However, these corrections have not been considered in the context of scattering from small anisotropic particles.
In this work [11] we analyze the polarizability of small dielectrically anisotropic particles including radiative corrections. We describe the general properties of any polarizability tensor consistent with the Optical Theorem and we derive a generalized polarizability tensor equivalent to the extended polarizability tensor arising in the so-called "strong couple dipole method " (S-CDM). We show that, in absence of absorption, it is consistent with the optical theorem. These results are of general applicability. As an important application, we are going to restrict ourselves to the magneto-optical case, where the presence of a magnetic field alters some of the non-diagonal components of the dielectric tensor. Depending on the relative orientation of the sample, incidence plane and magnetic-field the affected elements will vary, conferring different effects. In the so-called "polar" configuration, where the magnetic field is applied perpendicular to the sample plane and parallel to the light incidence plane and the main effect is a rotation of the polarization state, it has been shown that the plasmon excitation largely modifies the rotation due to the strong enhancement and localization of the EM field. As we will show, the polarizability given by Eq. (1) wrongly predicts the absence of Kerr rotation for non-absorbing magneto-optical particles.

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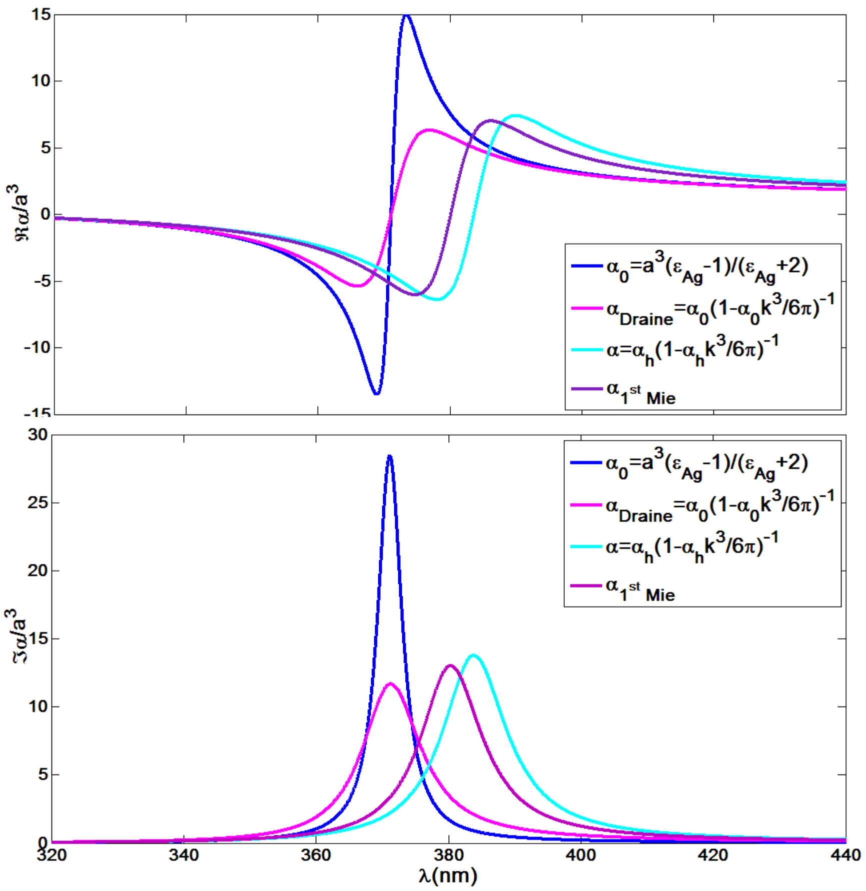
## Figures




Normalized real and imaginary parts of electric polarizability in terms of the wavelenght for a 25nm silver particle for different radiative corrections.