The mechanical action of the spin curl optical forces

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Abstract

The scattering force on dipolar particles, which is proportional to the imaginary part of the polarizability of the particle and to the phase gradients of the fields [1-3] is traditionally considered to be proportional only to the Poynting vector, but there is an additional contribution [4,5] proportional to the curl of the spin angular momentum of the light field [6]. The contribution to the scattering force given by the full Poynting vector plus this spin curl contribution is equivalent to consider only the so-called orbital component of the Poynting vector [7-9].The mechanical action of these spin forces is important, for example, in the focal volume of microscope objectives [10-12] and in evanescent fields [13,14].

In this work we explicitly show the importance of the non-conservative force coming from the curl of the spin density of the light field in stationary wave configurations [6,15] where it is possible to find arrangements with an effective value of the Poynting vector different from zero but no scattering force at all, and arrangements with a null value of the Poynting vector and an effective scattering force coming purely from the spin density of the light field.

We also analyze the mechanical action of the spin curl force on the focal plane of particular, non-homogeneous wave fronts, where the scattering force on a dipolar particle does not follow the Poynting vector [16]

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