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Optical scattering forces generated by high numerical aperture microscope objectives

Ignacio Iglesias[1] and Juan José Sáenz[2]

[1]*Depto. de Física, Universidad de Murcia, Campus de Espinardo (CIOyN Bldg.), 30100 Murcia, Spain*
[2]*Depto. de Física de la Materia Condensada, Universidad Autónoma de Madrid, 28049 Madrid, Spain*

E-mail: iic@um.es

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A detailed description of the dynamics of particles trapped or moved by light is needed for an increasing number of applications. The characteristics and control of light-induced trajectories of particles in fluids[1] or the precise stiffness determination when small trapped particles confined by light are used as probes in force microscopy[2] are just two examples.
It has been shown that the forces involved can be classified as conserving or not mechanical energy. In the past, only the conservative term, arising from the gradient of the optical intensity distribution, was considered[3]. Recently, the relevance of the force generated by the radiation pressure has also been highlighted[4, 5]. Although this term has been traditionally assumed to be the only non-conservative contributor to the total force field, with small Rayleigh particles, another term may be crucial: the force generated by the curl of the spin angular momentum of the light field[6].
While the contribution to the total force of the spin angular momentum has been studied for optical fields in optical lattices[6-8], we demonstrate here how this term also plays a significant role in the total non-conservative force emerging in the focal volume of high numerical aperture objectives.

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