Magneto-optical Stren-Gerlach forces and non-reciprocal torques on small particles

Manuel I. Marqués[1]
S. Edelstein[2]
R. M. Abraham Ekeroth[3,4]
P. A. Serena[2]
J. J. Sáenz[5,6]
A. García-Martín[4]

[1] Departamento de Física de Materiales, Condensed Matter Physics Center (IFIMAC) and Instituto Nicolás Cabrera, Universidad Autónoma de Madrid, Madrid 28049, Spain
[2] Instituto de Ciencia de Materiales de Madrid (ICMM-CSIC), Campus de Cantoblanco, 28049 Madrid, Spain
[3] Instituto de Física Arroyo Seco, U. Nacional del Centro de la Provincia de Buenos Aires, Pinto 399, 7000 Tandil, Argentina
[4] Instituto de Micro y Nanotecnología IMN-CNM, CSIC, Isaac Newton 8, Tres Cantos, Madrid 28760, Spain
[5] Donostia International Physics Center (DIPC), Paseo Manuel Lardizabal 4, 20018 Donostia-San Sebastian, Spain
[6] IKERBASQUE, Basque Foundation for Science, Bilbao 48013, Spain

manuel.marques@uam.es

In this work, we calculate the optical forces [1] and torques caused by the presence of a sizeable magneto-optical effect [2]. We find a conservative force proportional to the gradient of the spin density of the light field and an extinction force proportional to the helicity of the light field. The conservative interaction allows for a spin-selective, magnetic field based Stern-Gerlach experiment, capable of differentiating between right and left circular polarizations. We also prove that by using a spin-less linearly polarized plane wave, the magneto-optical effect allows for the existence of a permanent non-reciprocal torque, proportional to the intensity of the light field [3].

References

[1] S. Albaladejo, M. I. Marqués, M. Laroche and J. J. Sáenz, Phys. Rev. Lett. 102, 113602 (2009).
[2] V. V. Temnov, G. Armelles, U. Woggon, D. Guzatov, A. Cebollada, A. García-Martín, J. M. García-Martíin, T. Thomay, A. Leitenstorfer, and R. Bratschitsch Nat. Photonics 4, 107 (2010).
[3] S. Edelstein, R. M. Abraham-Ekeroth, P. A. Serena, J. J. Sáenz, García-Martín,and M. I. Marqués, Phys. Rev. Res. 00, 003000 (2019).