Magneto-Optical Control of Radiative Heat Transfer and Optical Forces.

A. García-Martín

Instituto de Micro y Nanotecnología IMN-CNM, CSIC (CEI UAM+CSIC), Tres Cantos, Madrid, Spain

Here, we show that magneto-optically resonant particles present a large anisotropic thermal magnetoresistance (ATMR) in the near-field radiative heat transfer when the direction of an external magnetic field is changed with respect to the heat current direction. We illustrate this effect with the case of two InSb particles where we find that the ATMR amplitude can reach values of up to 800% for a magnetic field of 5 T, orders of magnitude larger than its spintronic analogue. We also show that this two InSb particles experience non-reciprocal forces leading to a Stern-Gerlach like effect and permanent non-reciprocal torque.

The combination of magneto-optical activity and resonant modes has proven itself as a simple, yet effective way to control the optical properties with externally applied magnetic fields (magnetoplasmonics). It has been shown that this interplay can be employed to modulate the propagation wavevector of SPPs or to enhance the magneto-optical response. Here we will show that they also play a crucial role in the active control thermal emission and the radiative heat transfer (RHT) between objects in the near and far field regime. In particular we will show that the Near Field RHT between two MO particles can be efficiently controlled by changing the direction of the magnetic field, in the spirit of the Anisotropic Magneto Resistance in spintronics. This phenomenon, which we term anisotropic thermal magnetoresistance (ATMR), is discussed through the analysis of the radiative heat exchange between two InSb particles, and show that the ATMR can reach amplitudes of 800% for a magnetic field of 5 T. Additionally, we show that two InSb particles experience non reciprocal forces, 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 show 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.

R. M. Abraham Ekeröth, et al., ACS Photonics 5, 705 (2018)

S. Edelstein, et al., Phys. Rev. Res. 1, 013005 (2019)