Optical non-reciprocity in magnetic Weyl semi-metals heterostructures

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In an optical reflective experiment, we shed light an a material from a source, and we measure the intensity of reflected electromagnetic modes using a detector. This measure is said to be reciprocal if it remains unchanged under the swapping of the source and the detector. Optical non-reciprocity has been proposed as a possible route to improve the efficiency of energy conversion devices, from solar cells to passive heat coolers. In this talk, we will explore the optical non-reciprocity of magnetic Weyl materials beyond the seminal works by Kotov and Lozovik [1,2].

Weyl semi-metals are topological materials that exhibit a linear dispersion relation near their electronic band crossings. Because such materials break time-reversal symmetry and display an analog Lorentz force when submitted to an external electric field, devices based on Weyl-semimetals are promising candidates to investigate optical non-reciprocity. We focus on identifying the physical origin of non-reciprocity in Weyl materials heterostructures.

Our investigations showed that optical non-reciprocity can be attributed to dissipation through plasmon-polariton modes. The analog Lorentz force acts differently on these modes depending on their direction of propagation: it either facilitates or frustrates the transverse displacement of electronic charges. Therefore an accurate description of the optical non-reciprocity of magnetic Weyl materials requires the understanding of the optical conductivity around the plasma frequency. We discuss an efficient numerical method to characterize it, based on the Kernel polynomial method [3]. Our numerical method is applied to compute the bulk conductivity and permittivity tensors for a lattice model description of Weyl semimetals[4]. This approach allows to supersede analytical predictions for the low frequency regime [5]. A deeper understanding of the electronic transport and the role of key model properties allow for a better optimization of non-reciprocity in optical devices designed using these materials.

References

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