Nonreciprocal electron hydrodynamics under magnetic fields: applications to nonreciprocal surface magnetoplasmons

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The past decades have seen a profound growth of interest in nonreciprocal responses, which are characterized by directional transport and propagation of quantum particles [1]. The responses are known to occur in material systems with broken inversion symmetry. Especially, a particular type of nonreciprocal responses occurs ubiquitously when the time-reversal symmetry (TRS) is further broken by applying a magnetic field or with spontaneous magnetization. More recently, the role of such nonreciprocity is being discussed in the context of electron hydrodynamics [2], which is quickly growing into a mature field of condensed matter physics.

Symmetry of crystals gives a new twist to the concept of electron hydrodynamics. Whereas previous works focused on symmetry breaking of either the inversion or TRS in the absence of magnetic field [3, 4], the role of nonreciprocity in electron hydrodynamics has not been well investigated yet. Thus the study of electron dynamics under magnetic fields with noncentrosymmetric hydrodynamic materials may reveal the role and open a new frontier of nonreciprocal electron hydrodynamics.

In this work, focusing on noncentrosymmetric metals, we formulate a theory of electron hydrodynamics with broken inversion symmetry under magnetic fields and find that novel terms emerge in hydrodynamic equations which play a crucial role for the realization of the nonreciprocal responses. From a symmetry viewpoint, we find that these terms can appear only in the systems without TRS and inversion symmetry. Furthermore, as a demonstration of our nonreciprocal electron hydrodynamic theory, we provide an analysis of *nonreciprocal surface magnetoplasmons* and show that they lead to the directional dichroism in the reflectance peaks in Kretschmann configuration.

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