Optical Hall effect and Veselago lensing in graphene

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When passing an optical medium in the presence of a magnetic field, the polarization of light can be rotated either when reflected at the surface (Kerr effect) or when transmitted through the material (Faraday rotation). This phenomenon is known as a direct consequence of the optical Hall effect arising from the light-charge carrier interaction in solid state systems subjected to an external magnetic field, in analogy with the conventional Hall effect. The optical Hall effect has been explored in many thin films and also more recently in 2D materials. An alternative approach based on strain engineering is proposed here to achieve an optical Hall conductivity in graphene without magnetic field [1]. Indeed, strain induces lattice symmetry breaking and hence can result in a finite optical Hall conductivity as predicted by first-principles and tight-binding calculations.

At p-n boundaries, graphene Dirac fermions behave as would photons encountering a negative index media, therefore experiencing a peculiar refraction known as Veselago lensing. However, the way Dirac fermions flow through a Veselago lens remains largely unexplored. Here, a novel approach to create a movable and highly tunable circular Veselago lens in graphene is proposed, based on the polarized tip of a scanning gate microscope and tight-binding simulations [2]. In particular, a high current density in the lens core, as well as two low current density points along transport axis, are evidenced, strongly depending on the p-n junction smoothness [2]. This research paves the way towards a deep understanding of Dirac fermions to engineer relativistic electron optical devices.

References

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Figures