Optical Hall effect in strained graphene

Jean-Christophe Charlier
Viet-Hung Nguyen and Aurélien Lherbier

Institute of Condensed Matter and Nanosciences, Université catholique de Louvain, Louvain-la-Neuve, Belgium

jean-christophe.charlier@uclouvain.be

Abstract

The Hall effect is a fascinating phenomenon describing electrical conduction transverse to an applied electric field which is usually obtained thanks to a magnetic field. Although most of the works have concentrated on static cases, the optical Hall effect is another exceptional feature [1]. When passing an optical medium subjected to an external 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 a direct consequence of the optical Hall effect arising from the light-charge carrier interaction in solid state systems in the presence of a magnetic field, in analogy with the conventional Hall effect. The optical Hall effect has been explored in many thin films [2] and also more recently in 2D layered materials [3]. In this work [4], an alternative approach based on strain engineering is proposed to achieve an optical Hall conductivity in graphene without magnetic field. Indeed, strain induces lattice symmetry breaking and hence can result in a finite optical Hall conductivity (see in Fig.1). First-principles calculations also predict this strain-induced optical Hall effect in other 2D materials. Combining with the possibility of tuning the light energy and polarization, the strain amplitude and direction, and the nature of the optical medium, large ranges of positive and negative optical Hall conductivities are predicted, thus opening the way to use these atomistic thin materials in novel specific opto-electro-mechanical devices.

References

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Figures

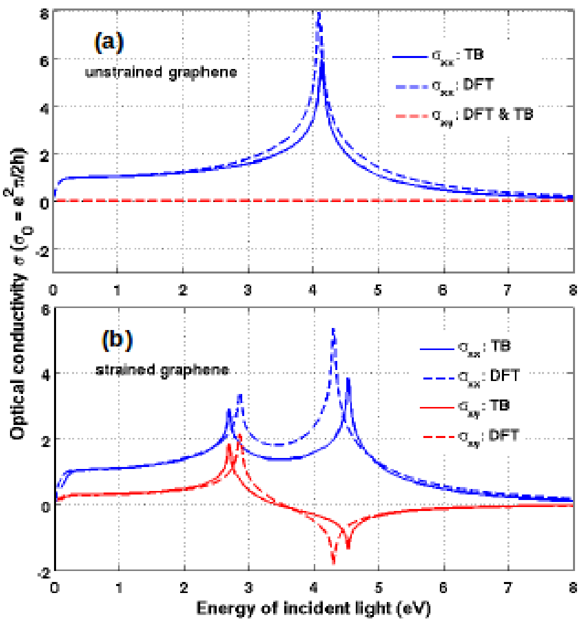

Fig. 1: Optical conductivities computed by density functional theory and tight binding approaches in graphene without (a) and with strain (b).