In-plane Magnetoelectric Response in Bilayer Graphene

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A graphene bilayer shows an unusual magnetoelectric response whose magnitude is controlled by the valley-isospin density, making it possible to link magnetoelectric behaviour to valleytronics (cf. Figure 1) [1-3]. Complementary to the previous study [2], we consider in this work the effect of static homogeneous electric and magnetic fields that are oriented parallel to the bilayer's plane [4]. Starting from a tight-binding description and using quasi-degenerate perturbation theory, the low-energy Hamiltonian is constructed including all relevant magnetoelectric terms whose prefactors are expressed in terms of tight-binding parameters. We confirm the existence of an expected axion-type pseudoscalar term, which turns out to have the same sign and about twice the magnitude of the previously obtained out-of-plane counterpart [2]. Additionally, small anisotropic corrections to the magnetoelectric tensor are found that are fundamentally related to the skew interlayer hopping parameter γ_4. We discuss possible ways to identify magnetoelectric effects by distinctive features in the optical conductivity.

References

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Figures

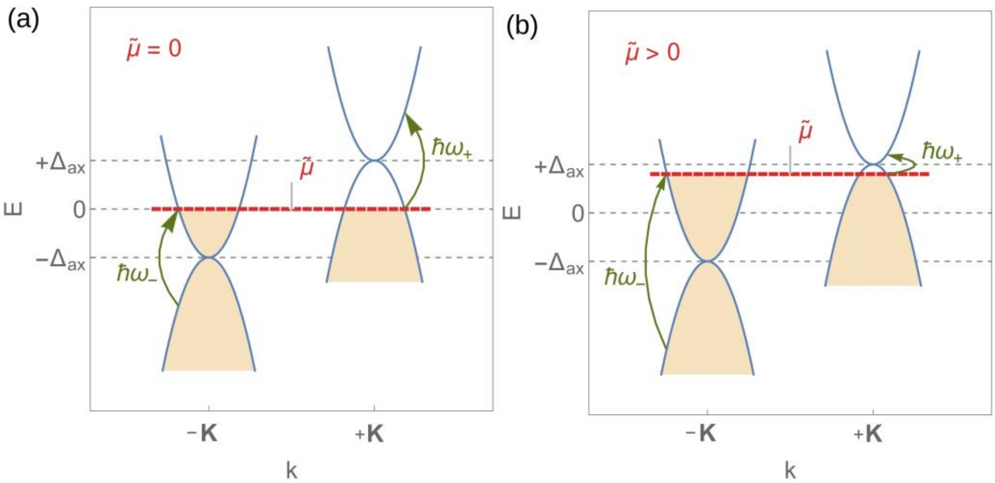

Figure 1: Valley-dependent optical absorption for different chemical potentials μ due to a valley-contrasting axion-like energy shift Δ_{ax} which results from the coupling of in-plane electric and magnetic fields. The minimum transition frequencies ω are (a) identical for μ=0, (b) distinct for finite μ and, thus, visible in the optical conductivity spectrum.