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Electric Field-Induced Valley Degeneracy Lifting in Uniaxial Strained Graphene: Evidence from Magnetophonon Resonance

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Abstract

We study the role of electron-phonon interaction on the magneto-phonon resonance (MPR) spectrum in uniaxial strained graphene, under crossed electric and magnetic fields.

We predict a new structure in the MPR spectrum consisting of a double peak line resulting from the valley degeneracy lifting induced by the electric field. We focus on the Γ point optical phonon modes coupled to the inter-Landau level transitions $0 \leftrightarrows \pm 1$ where MPR is expected to be more pronounced at high magnetic field [1]. We derive the frequency shifts and the broadenings of the longitudinal (LO) and transverse (TO) optical phonon modes taking into account the effect of the strain modified electronic spectrum on the electron-phonon coupling. We show that the double peak structure of MPR line is due to the different Landau level spacings in the two Dirac valleys originating from the simultaneous action of the inplane electric field and the strain induced Dirac cone tilt [2,3]. This effect gives rise to a valley dependent electron-phonon interaction leading to a double peak structure in the MPR line (Figure 1) [4].

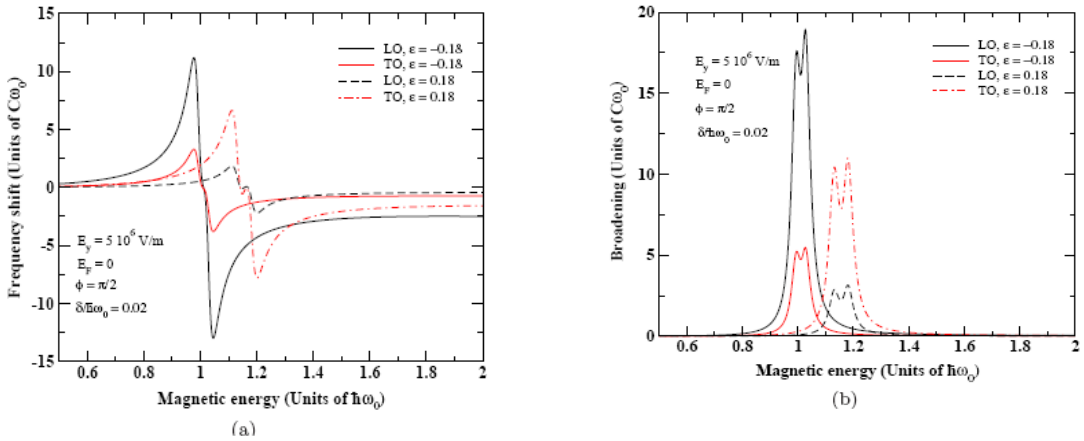

Figure 1: Frequency shifts (a) and the broadenings (b) of the LO and the TO modes as a function of the magnetic energy for a compressive (-18%) and a tensile (18%) deformations under a uniform electric field of 5 × 106 V.m^{-1} and for a given disorder amount δ [4].

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References

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