Dear Editor,

Please find our submission “Charge tuning of non-resonant magneto-exciton phonon interactions in graphene” by Remi, Goldberg and Swan. We hope that you will find the manuscript suitable for publication in Physical Review Letters.

Magneto-phonon resonances in graphene is yet another interesting manifestation of Dirac fermion quasiparticles. Magneto-phonons where predicted in 2007 and observed for the first time in 2009, and have been explored in a handful of publications since then. Prior work has all focused on the resonant coupling regime, and employ tuning of the magnetic field to explore the coupling. Our work focuses on the non-resonant regime and employs charge tuning to explore magneto exciton phonon coupling.

By tuning the filling factor at constant non-resonant B field, we demonstrate that we can extract the electron-phonon coupling and the resonant position of interband and intra band transitions. The further out the tuning is extended from ν=0, the greater the number of contributing transitions, each onset causing kinks in the phonon energy vs filling factor data. We vary ν from +/- 10, and extract contributions from 5 interband and 4 intraband transitions. Charge tuning also causes splitting of the phonon energy and is due to Pauli blocking of two orthogonal polarization excitations, a tunable optical dichroism response.

We show that in a non-resonant B field, the filling factor dependence causes a linear response on the phonon energy. This is in contrast to resonant coupling that leads to a square root dependence on the filling factor. The measured coupling strength, broadening and Fermi velocity is in good agreement with independent observations at B = 0 T and earlier experiments