Orbital diamagnetism and broken symmetries in strained induced graphene quantum dot

Kang-Hun Ahn[1,2] and Kyung-Joong Kim[1]

[1]Department of Physics, Chungnam National University, Daejeon 305-764, Republic of Korea
[2]Department of Physics, University of Bath, Bath BA2 7AY, United Kingdom
ahnkh@cnu.ac.kr

Recently, the successful preparation of grapheme [1,2]- has provided the opportunity of theoretical and experimental research of one-atom layer nanoelectronics. Naturally, quantum dot, which confines quasi-particles in zero dimensional states, is an important building block for nanoelectronic application. In graphene where the quasi-particles are described by massless Dirac Fermions, confinement is nontrivial issue since the quasi-particles can penetrate large and wide electrostatic barrier through Klein tunneling[3]. To overcome the obstacle of the confinement, it has been suggested to confine quasiparticles via electrostatic potential in graphene stripes[4,5,6], or via magnetic barrier[7]. In principles, graphene dots can be realized by a spatially inhomogeneous magnetic field[8,9]. The required magnetic field strength, however, is too big for nanoelectronics application.

Here, we will show that graphene quantum dot can be formed via experimentally accessible size of strain due to its unique topology and strength of the pseudo-magnetic field formed in graphene. More interestingly, the orbital magnetic response of the strained graphene will be very sensitive to the applied strain, which might be useful for sensor application. The pseudo magnetic field appears when lattice defects, the intrinsic and extrinsic curvature of the graphene sheets and the variation of hopping energies by elastic strains enter into the Dirac equation [10,11,12,13]. It will be demonstrated here that the strained graphene breaks its mirror reflection symmetry (MRS) and time reversal symmetry (TRS) by application of `real' magnetic field, which originated from the particular symmetry of the pseudo-magnetic field. It will be shown that the interplay between the real and pseudo magnetic field manifests by the orbital diamagnetism of the localized state in graphene quantum dot.

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