The electronic properties of graphene quantum dots in a strong magnetic field

Paweł Potasz[1], Devrim Güçlü[2], Błażej Jaworowski[1], and Paweł Hawrylak[3]

[1] *Institute of Physics, Wrocław University of Technology, PL-50-370 Wrocław, Poland*
[2] *Department of Physics, Izmir Institute of Technology, IZTECH, TR35430, Izmir, Turkey*
[3] *Quantum Theory Group, Security and Disruptive Technology, Emerging Technologies Division, National Research Council of Canada, Ottawa, Canada and Department of Physics, University of Ottawa, Ottawa, Canada*

Electronic properties of graphene quantum dots (GQD) in an external magnetic field are investigated [1, 2, 3, 4, 5]. Single particle properties are studied using tight-binding approximation with magnetic field included via Peierls substitution [6]. Electron-electron interactions are treated via Hartree-Fock and configuration interaction method (tb-HF-CI)[7, 8, 9]. Recent theoretical works were focused on detail analysis of single particle energy spectra of graphene quantum dots with variety of shapes and edge termination [5, 10, 11]. In this work, we present new theoretical results regarding single particle and many-body effects in triangular GQDs with zigzag edges (TGQD) that exhibit a shell of degenerate states at the Fermi level, in the middle of a size dependent energy gap [12]. We show numerically and prove semi-analytically that the degenerate shell is immune to the magnetic field. Next, we study the formation of the states of the $n = 0$ Landau level ($0LL$) close to the Fermi level as a function of increasing magnetic field. At higher magnetic field the $0LL$ states become energetically degenerate with the zero-energy shell. We analyze electronic interactions between electrons from the degenerate shell and electrons from $0LL$ states. We study the ground state and total spin of TGQD as a function of the magnetic field. We show that electrons from the zero-energy shell are spin polarized and act on electrons from $0LL$ as effective magnetic field due to exchange interaction flipping their spins. This allows us to derive an approximate single particle phase diagram with electrons from the zero-energy shell included in an effective g^*-factor.

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