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Influence of minivalleys and Berry curvature on electrostatically induced nanostructures in gapped bilayer graphene

Abstract: We theoretically investigate the properties electrostatically confined nanostructures in gapped bilayer graphene (BLG). We show how the spectrum of subbands in a quantum wire in gapped BLG, and the energy levels in a quantum dot, manifest the minivalley structure and Berry curvature via the associated magnetic moment of the states in the low-energy bands. These features determine the degeneracies of the low-energy minibands / -levels and their valley splitting, which develops linearly in a weak magnetic field. In a quantum point contact, magneto-conductance reflects such degeneracies in the heights of the first conductance steps which develop upon the increase of the channel doping: 8e2/h steps in a wide channel in BLG with a large gap, 4e2/h steps in narrow channels, all splitting into a staircase of 2e2/h steps upon lifting valley degeneracy by a magnetic field B. For quantum dots, we investigate how optical selection rules are influenced by the minivalleys and the orbital magnetic moment, as well as by shapes of the confinement.

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