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Theoretical studies of graphene nanoribbon quantum dot qubits[1]
CHIH-CHIEH CHEN, Department of Physics, Zhejiang University, YIA-CHUNG CHANG, Research Center for Applied Sciences, Academic Sinica — Graphene nanoribbon quantum dot qubits have been proposed as promising candidates for quantum computing applications to overcome the spin-decoherence problems associated with typical semiconductor (e.g., GaAs) quantum dot qubits. We perform theoretical studies of the electronic structures of graphene nanoribbon quantum dots by solving the Dirac equation with appropriate boundary conditions. We then evaluate the exchange splitting based on an unrestricted Hartree-Fock method for the Dirac particles. The electronic wave function and long-range exchange coupling due to the Klein tunneling and the Coulomb interaction are calculated for various gate configurations. It is found that the exchange coupling between qubits can be significantly enhanced by the Klein tunneling effect. The implications of our results for practical qubit construction and operation are discussed.

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Chih-Chieh Chen
Department of Physics, Zhejiang University

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