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(G) Broken Sublattice Symmetry Effects and Phase Transitions in Triangular Artificial Graphene Quantum Dots

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We describe here the effects of broken sublattice symmetry, and the emergence of a phase transition in triangular artificial graphene quantum dots with zigzag edges. The system consists of a structured lateral gate confining two dimensional electrons in a quantum well into artificial minima arranged in a hexagonal lattice. The sublattice symmetry breaking is generated by forming an artificial triangular graphene quantum dot with zigzag edges. The resulting Hamiltonian of this system generates a tunable ratio of tunneling to strength of electron-electron interactions and a degree of sublattice symmetry with control over shape. Using a combination of tight binding, Hartree-Fock and configurations interaction we show that the ground state transitions from a metallic to an antiferromagnetic phase by changing the distance between sites or depth of the confining potential. At the single particle level these triangular dots contain a macroscopically degenerate shell at the Fermi level. The shell persists at the mean-field level (Hartree Fock) for weak interactions (metallic phase) but disappears for strong interactions (antiferromagnetic phase). We determine the effects of electron-electron interactions on the ground state, the total spin, and the excitation spectrum as a function of filling of the system away from half-filling. We find that the half-filled charge neutral system leads to a fully spin polarized state in both metallic and antiferromagnetic regimes in accordance with Lieb's theorem. In both regimes a relatively large gap separates the spin polarized ground state to the first excited many-body state at half-filling of the degenerate shell, but by adding or removing an electron, this gap drops dramatically, and alternate total spin states emerges with energies nearly degenerate to a spin polarized ground state.

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