Wigner Crystallization in Graphene Nanoribbons

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We investigate the Wigner crystallization of electrons and holes at the zigzag edges of graphene nanoribbons using many-body configuration interaction method. We show that Wigner crystallization occurs at a surprisingly high electronic density, 0.8 nm^{-1} (see Fig.1). In contrast with one-dimensional electron gas, the flat-band structure of the edge states makes the system interaction dominated, facilitating the electronic localization. The Wigner localization is found to affect strongly the magnetic coupling between the nearest neighbour electrons, causing an antiferromagnetic-ferromagnetic phase transition. As the width of the ribbon is decreased below 16 Å, interedge coupling becomes important, hence increased kinetic energy overcomes the long-range Coulomb repulsion and suppresses the Wigner crystallization. Finally, we show that Wigner crystallization can also occurs for holes, albeit weaker than for electrons.

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References:

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