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Quasiparticle weight and renormalized Fermi velocity of graphene with long-range Coulomb interactions[1] HO-KIN TANG, JIA NING LEAW, J. N. B. RODRIGUES, Department of Physics, National University of Singapore, P. SENGUPTA, School of Physical and Mathematical Sciences, Nanyang Technological University, F. F. ASSAAD, Institut fr Theoretische Physik und Astrophysik, Universitt Wrzburg, S. ADAM, Department of Physics, National University of Singapore
— In this work, we study the effects of realistic Coulomb interactions in graphene using a projective quantum Monte Carlo simulation of electrons at half-filing on a honeycomb lattice. We compute the quasiparticle residue, the renormalized Fermi velocity and the antiferromagnetic order parameter as a function of both the long-range and short-range components of the Coulomb potential. We find that the Mott insulator transition is determined mostly by the short-range interaction and is consistent with the Gross-Neveu-Yukawa critical theory. Far from the critical point and in the semi-metallic regime, we find that the Fermi-velocity and quasiparticle residue are influenced by the long-range tail of the Coulomb potential, and for very small interaction strength are consistent with predictions of first order perturbation theory. For experimentally relevant and stronger values of the long-range interaction, our numerical data contradicts prediction from both perturbation theory and the renormalization group approaches.

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