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Analysis of fermions on a honeycomb bilayer lattice with finite-range interactions in the weak-coupling limit[1]

ROBERT THROCKMORTON, OSKAR VAFEK, Florida State University, National High Magnetic Field Laboratory — We extend previous analyses of fermions on a honeycomb bilayer lattice via weak-coupling renormalization group (RG) methods with extremely short-range and extremely long-range interactions to the case of finite-range interactions. In particular, we consider different types of interactions including screened Coulomb interactions, much like those produced by a point charge placed either above a single infinite conducting plate or exactly halfway between two parallel infinite conducting plates. We map out the phases that the system enters as a function of the range of the interaction. For spin-$\frac{1}{2}$ fermions, we discover that the system enters an antiferromagnetic phase for short ranges of the interaction and a nematic phase at long ranges, in agreement with the previous work. Our results can help reconcile the recent results of two seemingly contradictory experiments. We also consider the effects of an applied magnetic field on the system in the antiferromagnetic phase via variational mean field theory, obtaining results in qualitative agreement with the experimental data. We find that the antiferromagnetic order parameter increases with field, at first quadratically at low fields, then as $B/\ln(B/B_0)$ at higher fields.

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