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Lattice gauge theory treatment of strongly correlated Dirac semimetals

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We study the strong correlation effect from Coulomb interaction in two- and three-dimensional Dirac semimetals. Effective field theory for the interacting Dirac semimetals can be constructed in terms of quantum electrodynamics (QED). We propose a U(1) lattice gauge theory formulation with the internal degrees of freedom, such as spin and orbitals (pseudospin), explicitly. In the strong coupling limit, the coupling to the U(1) gauge field leads to local charge neutrality, which can be expressed as a sufficiently strong Hubbard (on-site) repulsion as well, rendering the system into a Mott insulator. We discuss the evolution of charge and spin orders by strong coupling expansion and mean-field analysis, and examine the effect of dimensionality and number of flavors.

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