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Classical phase diagram of the Rashba-Hubbard model in the strongly correlated limit on square lattice

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Abstract

In this work, we investigate the interacting electrons on a square lattice in the presence of Rashba spin-orbit coupling. We first obtain the effective spin model from the Rashba-Hubbard model in the strongly correlated limit using the second perturbation theory. The effective spin model includes isotropic Heisenberg terms, nearest- and next-nearest-neighbor interactions, as well as the anisotropic ones as Kane-Mele and Dzyaloshinski-Moriya interactions. We proceed to study the influence of Rashba spin-orbit coupling on the stability of the magnetic phases of isotropic Heisenberg using Luttinger-Tisza and variational minimization classical methods. Our classical calculations show that the anisotropic terms leads to the instability of the Neel, classical degenerate and collinear phases of the isotropic Heisenberg model on the square lattice into an incommensurate planar phase. The spiral magnetic order in the two-dimensional frustrated magnets can be disordered by considering the quantum fluctuations. In a heterostructure including a noncollinear magnet and a singlet superconductor, singlet Cooper pairs can be converted to triplet pairings due to the broken spin rotational symmetry. Therefore, we can engineer a topological superconductor using noncollinear magnet in a heterostructure system.

Keywords: spin-orbit coupling, in-plane spiral order, Luttinger-Tisza and variational methods

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