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Competition between superconductivity and antiferromagnetism as a boson-fermion mixture problem GERARDO ORTIZ, LEONID ISAEV, Indiana University - Dep. of Physics, CRISTIAN D. BATISTA, Los Alamos National Lab — It is widely believed that the key to understanding the mechanism of superconductivity in cuprate materials and heavy fermion compounds lays in the competition between two quantum orders: superconductivity and antiferromagnetism, which complicates the choice of relevant effective degrees of freedom. Here we present a new isomorphic mapping, preserving the dimension of the on-site Hilbert space, where holons are represented by fermionic and spinons – by bosonic degrees of freedom, which, we claim, are the relevant ones in a certain regime (low density). Starting from t-J – like models we show that the original Hamiltonian can be exactly mapped onto a mixture of interacting fermion and boson gases. It is then demonstrated that this system may be considered as dilute under certain experimentally reasonable conditions. In this limit we show that the fermion gas exhibits a pairing instability, caused by a two boson exchange, which implies superconductivity of holons in the original repulsive model. Although the long-range Coulomb interaction is, in principle, capable of suppressing this state, we argue about a physical mechanism for its compensation, which is relevant for real materials. Our results also lead to a mechanism for superfluidity in ultracold boson – fermion gas mixtures.

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