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Quantum Phases of Atom-Molecule Mixtures of Fermionic Atoms

NICOLAS LOPEZ, UCR — Nicolas Lopez (University of California, Riverside, USA) Chi-Yong Lin (National Dong Hwa University, Taiwan) Shan-Wen Tsai (University of California, Riverside, USA) Cold atom experiments have realized a variety of multicomponent quantum mixtures, including Bose-Fermi atomic mixtures. Mixtures of fermionic atoms and diatomic molecules, which are boson, have also been obtained by tuning of the interactions with external fields [1]. We study many-body correlations in such a system where the molecules are weakly bound and therefore pairs of fermionic atoms easily convert into and dissociate from the bound molecule state and this exchange mediates a long-range interaction between the fermions. We consider a simple many-body Hamiltonian that includes the destruction of fermionic atom pairs to form single bosonic molecules and vice versa [2]. We employ a functional renomalization-group approach and calculate the renormalized frequency-dependent interaction vertices and fermion self-energies. We find an instability from the disordered quantum liquid phase to a BCS phase and calculate the energy scale for the transition. The unusual frequency-dependence of this mediated interaction leads to strong renormalization of the self-energy, and also affects the couplings in the BCS channel. [1] M. Greiner, C. A. Regal, J. T. Stewart, and D. S. Jin, Phys. Rev. Lett. **94**, 110401 (2005) [2] E. Timmermans, K. Furuya, P. W. Milonni, and A. K. Kerman, Phys. Lett. A **285**, 228 (2001)

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