Zero-temperature phase diagram of Bose-Fermi gaseous mixtures in optical lattices

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We study the ground state phase diagram of a mixture of bosonic and fermionic cold atoms confined on two- and three-dimensional optical lattices. The coupling between bosonic fluctuations and fermionic atoms can be attractive or repulsive and has similarities with electron-phonon coupling in crystals. We investigate behavior of the mixtures in the limit, where the Bogoliubov sound velocity that dictates bosonic dynamics is comparable to the Fermi velocity, hence the retardation effects are important part of the physics. The dynamic Lindhard response function of the fermionic density to changes in the bosonic number of particles above some critical frequency can alter the sign and in consequence the inter-species interaction between particles becomes repulsive in contrast to the static limit (instantaneous and always attractive). Considering the above we show that the structure of the phase diagrams crucially depends on the difference in masses of the bosons and fermions. We discuss the situations where integrating out fermionic field provides an additional interaction that can decrease or increase bosonic coherence.

9.7 cm

13.4 cm

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