Localization of Bose-Fermi Mixtures in One-Dimensional Incommensurate Lattices

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Disordered Bose systems with strong correlation, described by Bose Hubbard models with disorder, have been one of the targets of theoretical and experimental investigation. Current interest is also directed towards disordered systems of ultracold atoms generated by using laser speckle patterns or additional incommensurate optical lattice potentials. Fallani et al.[1] observed a localization transition of strongly interacting ^{87}Rb bosons in incommensurate lattices, which suggested the formation of a Bose glass.

We will present the results of quantum Monte Carlo simulations of Bose-Fermi mixtures in one-dimensional incommensurate lattices. We observed localization as the strength of the incommensurate potential increases. We also found a characteristic behavior of the superfluid density when changing the Bose-Fermi interactions over a wide range. The superfluidity is enhanced by itinerant fermions when the strength of repulsive Bose-Fermi interactions becomes comparable to that of repulsive Bose-Bose interactions. On the other hand the superfluidity is enhanced in some cases and not in other cases with attractive Bose-Fermi interactions. The occurrence of the enhancement strongly depends on the particle densities and the Bose-Bose interactions. We propose a mechanism of these phenomena, showing snapshots of the imaginary-time evolutions of the particles and the dynamical structure factors.

[1] L. Fallani et al., Phys. Rev. Lett. **98**, 130404 (2007).