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Multi-orbital and density-induced tunneling in optical lattices
DIRK-SOEREN LUEHMANN, OLE JUERGENSEN, KLAUS SENGSTOCK, University of Hamburg — We show that multi-orbital and density-induced tunneling have significant impact on the phase diagrams of atoms in optical lattices. In these systems, higher-band processes and off-site interactions constitute an important extension to the established and well-studied Hubbard model. Off-site interactions lead to density-induced hopping, so-called bond-charge interactions, which can be identified with an effective tunneling potential. We introduce dressed operators for the description of multi-orbitally renormalized tunneling, on-site, and bond-charge interactions. By means of an extended occupation-dependent Hubbard model, the phase diagrams for bosonic systems and Bose-Fermi mixtures is derived. It substantially deviates from the single-band Hubbard predictions leading to strong changes of the superfluid to Mott-insulator transition point. The presented results have direct relevance for optical lattice experiments with tunable interactions.

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