SFB/TRR 21 - Seminar

17. December 2012, Ulm

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Ultracold atoms in one dimension: from two to many

We will discuss ultracold bosonic and fermionic systems are studied with respect to their stationary and dynamical properties in one-dimensional harmonic traps and finite lattices. All physical systems explored within this work, are treated with a bottom-up approach, inspired from the underlying two-body problem. This perspective is at the most illustrated from the correlated-pair wavefunction, an Ansatz proposed here to describe the crossover from weak to strong interactions for bosons and fermions trapped in a one-dimensional harmonic potential. The underlying idea of the Ansatz is to employ the exact solution of the corresponding two-body system for the construction of a many-body correlated function.

Furthermore finite lattices loaded with commensurate and incommensurate filling are investigated, with a focus on on-site effects induced from strong interactions beyond the validity regime of standard single-band approaches. A generalization of the correlated-pair wavefunction to lattice potentials is performed to cover these effects. Interband tunneling dynamics in finite lattices occur due to resonances in the many-body spectrum at certain typically strong interaction strengths breaking the self-trapping mechanism. The properties of the observables resulting from the analytical functions proposed here are compared with corresponding ones calculated by established computational methods:

Multi-Configurational Time-Dependent Hartree and Quantum Monte Carlo.

Recent experimental data obtained after deterministic preparation of few-fermion ensembles in a trap (Selim Jochim-Heidelberg) are in very good agreement with theoretical calculations performed in this work.

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