Q 38: Quantengase: Gemische

Zeit: Mittwoch 16:30–18:00 Raum: VMP 6 HS-A

Q 38.1 Mi 16:30 VMP 6 HS-A

Probing interaction effects in Bose-Fermi mixtures in optical lattices — •Thorsten Best[1], Sebastian Will[1], Simon Braun[1], Ulrich Schneider[1], Lucia Hackermüller[1], Dirk-Sören Lühmann[2], and Immanuel Bloch[1] — [1]Johannes Gutenberg-Unversität Mainz — [2]Universität Hamburg

Mixtures of ultracold Bosons and Fermions in optical lattices are promising candidates for the investigation of intriguing complex quantum phases, some of which go beyond the scope of conventional condensed-matter systems. The key control parameter for the mixture, which is the strength of interspecies interaction, can conveniently be tuned in the experiment by means of an interspecies Feshbach resonance, combined with rapid hyperfine transitions in and out of the resonant collision channel.

The observation of the collapse and revival dynamics of a macroscopic bosonic matter wave field, and its modification by a fermionic admixture, provides copious information about the Bose-Fermi mixture. We extract how the interspecies interaction affects the occupation number statistics in the system. Moreover, we demonstrate the importance of orbital effects beyond the usual single-band picture, leading to a renormalization of the Hubbard parameters. A detailed understanding of these effects will be an important prerequisite for the preparation of complex many body quantum states in Bose-Fermi mixtures.

Q 38.2 Mi 16:45 VMP 6 HS-A

Self-Trapping of Bosons and Fermions in Optical Lattices — •Dirk-Sören Lühmann[1], Kai Bongs[2,3], Klaus Sengstock[2], and Daniela Pfannkuche[1] — [1]I. Institut für Theoretische Physik, Universität Hamburg, Germany — [2]Institut für Laser-Physik, Universität Hamburg, Germany — [3]MUARC, University of Birmingham, UK

Degenerate mixtures of bosonic and fermionic atoms in three-dimensional lattices offer new insight into strongly correlated many-body physics. Already for the single-band Hubbard model, the interplay between interaction and tunneling is reflected in a complex phase diagram. Experimentally, the presence of fermions leads primarily to a reduction of the bosonic superfluidity for attractive interspecies interaction [1-3], which is apparently not covered by ridgid single-band physics. We theoretically investigate [4] the enhanced localization of bosonic atoms allowing for orbital changes and find a self-trapping of the bosons. The fermionic orbitals are substantially squeezed, which results in a strong deformation of the effective potential for bosons. We introduce a renormalized Bose-Hubbard model to predict the critical lattice depth using effective bosonic tunneling and on-site interaction. The results, in general, demonstrate the important role of orbital renormalization and are in good agreement with the recent experiment in Ref. [3], where Feshbach resonances are used to tune the boson-fermion interaction.

[1] K. Günter et al., PRL 96, 180402 (2006). [2] S. Ospelkaus et al., PRL 96, 180403 (2006). [3] Th. Best et al., PRL (in press), arXiv:0807.4504. [4] D.-S. Lühmann et al., PRL 101, 050402 (2008).

Q 38.3 Mi 17:00 VMP 6 HS-A

Nonlinear corrections to the BFHM induced by higher Bloch band — •Alexander Mering and Michael Fleischhauer — Fachbereich Physik, Technische Universität Kaiserslautern, Germany

Experiments with ultracold atoms in deep lattices are mostly described theoretically by means of single band Hubbard-type Hamiltonians. For increasing interactions it is however necessary to take into account higher band effects. We present analytic calculations of the higher band corrections both of the hopping amplitudes J and the interaction amplitudes U and V for intra- and interspecies interaction in the Bose-Fermi-Hubbard Hamiltonian and derive nonlinear corrections to the hopping amplitudes mediated by the inter-species interaction. We adiabatically eliminate the higher bands by means of a second order perturbation theory using the exact solution of the dynamics in all higher bands. From these corrections the shift of the Mott insulator to superfluid transition caused by the coupling to the higher bands can be determined as a function of the filling and the interspecies scattering strength. Further simplification can be obtained by using harmonic oscillator approximation for the wannier functions yielding purely analytic results for the amplitudes J, U and V.

Q 38.4 Mi 17:15 VMP 6 HS-A

Interaction dependent adiabatic heating of Bose-Fermi mixtures in optical lattices — •Marcus Cramer — Imperial College London, UK

In recent experiments with Bose-Fermi mixtures in optical lattices a decrease in bosonic coherence as compared to the purely bosonic case has been observed [1-3]. This effect has been attributed to adiabatic heating [4] and to a renormalization of interaction and tunneling amplitudes [5]. Here, we investigate in detail the role of the inter-species interaction in the adiabatic heating process and determine the final temperature of the mixture in the lattice. Within a Hartree-Fock-Bogoliuobov mean-field approach, we are able to treat the full three dimensional situation including the (anisotropic) harmonic confinement. We find remarkable qualitative agreement between the obtained increase in temperature and the recently observed decrease of coherence as a function of the Bose-Fermi interaction [3], suggesting that temperature effects could be one of the main causes for the loss of coherence.

[1] S. Ospelkaus *et al.*, Phys. Rev. Lett. **96**, 180403 (2006).
[2] K. Günter *et al.*, Phys. Rev. Lett. **96**, 180402 (2006).
[3] Th. Best *et al.*, arXiv:0807.4504.
[4] M. Cramer *et al.*, Phys. Rev. Lett. **100**, 140409 (2008).
[5] D.-S. Lühmann *et al.*, Phys. Rev. Lett. **101**, 050402 (2008).

Q 38.5 Mi 17:30 VMP 6 HS-A

Interspecies interaction in a strongly imbalanced Bose-Bose mixture — •Tatjana Weikum, Shincy John, Nicolas Spethmann, Claudia Weber, Artur Widera, and Dieter Meschede — Institut für Angewandte Physik, Universität Bonn, Wegelerstr. 8, D-53115 Bonn, Germany

We magnetically trap a Bose-Bose mixture of Rubidium and few Caesium atoms simultaneously. Cs is sympathetically cooled by evaporatively cooled Rb in a magnetic trap to a temperature below 1 μK. The ultracold mixture is loaded into an optical dipole trap. We will present the latest results on the interspecies interaction in an external homogeneous magnetic field. A sensitive fluorescence detection technique is incorporated into the experiment to be able to observe single or very few Cs atoms.

Q 38.6 Mi 17:45 VMP 6 HS-A

Strongly interacting Lithium Rubidium mixtures — •Carsten Marzok, Benjamin Deh, Reinhard Maier, Alexander Schilke, Philippe W. Courteille und Claus Zimmermann — Physikalisches Institut, Universität Tübingen, 72076 Tübingen

Ultracold atomic gases are a versatile instrument allowing to study the rich field of many body physics with unprecedented control. In this context, the Li-Rb system can provide particular insights owing to the large mass ratio. Additionaly, both Fermi-Bose mixtures (^{6}Li-^{87}Rb) and Bose-Bose mixtures (^{7}Li-^{87}Rb) can be realized in the same apparatus, further enlarging the range of possible experiments. Up to now, experiments in the strongly interacting regime with these isotopes were hampered by an imprecise knowledge of the heteronuclear scattering parameters particularly with respect to Feshbach resonances. In a series of experiments we now have located two such resonances in the Fermi-Bose-mixture and five in the Bose-Bose mixture. Based on these observations, groups in Berlin (Saenz) and Hannover (Tiemann) have determined the potential curves such that the scattering properties are now well described. We present our experimental observations of the Feshbach resonances and our progress towards the study of the strongly interacting mixtures by means of Bragg spectroscopy.