Q 60: Quantengase (Gemische / Tunneleffekte)

Zeit: Freitag 11:00–13:00 Raum: 3G/H

Q 60.1 Fr 11:00 3G/H

Interacting Rubidium and Caesium Atoms — •Claudia Weber, Michael Haas, Shincy John, Nicolas Spethmann, Lars Steffens, Artur Widera, and Dieter Meschede — Institut für Angewandte Physik, Universität Bonn, Wegelerstr. 8, 53115 Bonn

In our experimental set up we magnetically trap a mixture of Rubidium and a few Caesium atoms simultaneously. We selectively cool only Rubidium atoms by a microwave field tuned to the Rubidium ground state hyperfine transition. Caesium is sympathetically cooled via elastic collisions with Rubidium. We are able to cool down the mixture to temperatures below 1μK. Analysing the dynamics of sympathetic cooling we have estimated a lower limit for the Rubidium-Caesium s-wave scattering length to 150 a_0. Our next step is to load the mixture in an optical dipole trap. Using an external homogeneous magnetic field we intend to tune the inter-species interaction. We will present our latest results.

Q 60.2 Fr 11:15 3G/H

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, Jungiusstr. 9, 20355 Hamburg, Germany — [2]Institut für Laser-Physik, Universität Hamburg, Luruper Chaussee 149, 22761 Hamburg, Germany — [3]Midlands Centre for Ultracold Atoms, School of Physics and Astronomy, University of Birmingham, Edgbaston, Birmingham B15 2TT, United Kingdom

The superfluid to Mott insulator transition is one of the paradigms of solid state physics that maps onto ultra cold atomic systems. The interaction between different kinds of atoms adds an additional degree of freedom to two-component atomic systems not present in the solid state counterpart.

We numerically investigate the enhanced localisation of bosonic 87Rb by fermionic 40K atoms in three-dimensional optical lattices and find a self-trapping of bosons and fermions. Due to the mutual interaction the fermion orbitals are substantially squeezed which results in a strong deformation of the bosonic effective potential. We show that orbital effects in attractively interacting atomic mixtures are non-negligible as they lead to a large shift of the critical point of the transition from a superfluid to a Mott-insulator, which is of direct relevance to recent experiments with 87Rb and 40K atoms.

Q 60.3 Fr 11:30 3G/H

Heteronuclear Feshbach resonances in a mixture of ultracold ^{87}Rb and ^{133}Cs atoms — •Andrea Prantner[1], Almar Lange[1], Karl Pilch[1], Gabriel Kerner[2], Francesca Ferlaino[1], Hanns-Christoph Nägerl[1], and Rudolf Grimm[1,2] — [1]Institut für Experimentalphysik, Innsbruck, Austria — [2]Institut für Quantenoptik und Quanteninformation,

In the last few years there has been a growing interest in the in the area of heteronuclear ultracold quantum gases and the production of heteronuclear molecules via Feshbach resonances. We present the first observation of heteronuclear Feshbach resonances in a mixture of ultracold ^{87}Rb and ^{133}Cs. We give an overview about our experimental setup and the procedure of sample preparation. One of the key ingredients to reach the ultracold limit is the implementation of simultaneous degenerate Raman sideband cooling on both species. This cooling technique allows us to get around 10^8 atoms, fully polarized in the lowest magnetic sublevel at a temperature of $\sim 1\mu K$ in a crossed dipole trap. We discuss the next steps towards double degeneracy and present our approach to produce ground state RbCs molecules starting from weakly bound Feshbach molecules.

Q 60.4 Fr 11:45 3G/H

Feshbach Resonances in a Lithium Rubidium Mixture — •Carsten Marzok, Benjamin Deh, Philippe W. Courteille, and Claus Zimmermann — Physikalisches Institut, Universität Tübingen, Auf der Morgenstelle 14, D-72076

Ultracold atomic gases are a versatile instrument allowing to study the rich field of many body physics with unprecedented control. Indeed the coupled dynamics is governed by few parameters only, namely temperature, masses of the constituents and the interactions between them. In ultracold gases these interactions are ruled by the s-wave scattering length. Control over this parameter is provided by magnetic Feshbach resonances. The physics involved can be enriched by choosing a mixture of different atomic species with different masses and different quantum statistics i.e. Bose-Fermi mixtures. The lithium-rubidium system is remarkable among these because of its large mass difference. In recent experiments we were able to detect two heteronuclear Feshbach resonances in the ^{6}Li-^{87}Rb system, that now make it possible to study the physics of this rich system in more detail. The characterization of these resonances and further experiments will be discussed in this presentation.

Q 60.5 Fr 12:00 3G/H

Do mixtures of bosonic and fermionic atoms adiabatically heat up in optical lattices? — •Marcus Cramer[1], Silke Ospelkaus[2], Christian Ospelkaus[2], Kai Bongs[2], Klaus Sengstock[2], and Jens Eisert[1] — [1]Blackett Laboratory, Imperial College London — [2]Institut für Laser-Physik, Universität Hamburg

Mixtures of bosonic and fermionic atoms in optical lattices provide a promising arena to study strongly correlated systems. In experiments realizing such mixtures in the quantum degenerate regime the temperature is a key parameter. We investigate the intrinsic heating and cooling effects due to an entropy-preserving raising of the optical lattice, identify the generic behavior valid for a wide range of parameters and discuss it quantitatively for the recent experiments with ^{87}Rb and ^{40}K atoms. In the absence of a lattice, we treat the bosons in the Hartree-Fock-Bogoliubov-Popov approximation, including the fermions in a self-consistent mean field interaction. In the presence of the full three-dimensional lattice, we use a strong coupling expansion. We find the temperature of the mixture in the lattice to be always higher than for the pure bosonic case, shedding light onto a key point in the analysis of recent experiments.

Q 60.6 Fr 12:15 3G/H

Heteronuclear Feshbach molecules in an ultracold Bose-Fermi Mixture — •Carsten Klempt, Thorsten Henninger, Oliver Topic, Lisa Kattner, Eberhard Tiemann, Wolfgang Ertmer, and Jan Arlt — Institut für Quantenoptik, Leibniz Universität Hannover, Welfengarten 1, D-30167 Hannover, Germany

Within the past decade, quantum degenerate bosonic and fermionic ensembles were investigated in detail. The use of Feshbach resonances now allows for precise control of the interactions in heteronuclear mixtures of two atomic species. Within our experiments, bosonic ^{87}Rb atoms are used to cool an ensemble of fermionic ^{40}K atoms to joint quantum degeneracy. This mixture provides the starting point for the detailed analysis and manipulation of the interactions.

Applying a homogeneous magnetic field up to 700G allows for the investigation of heteronuclear Feshbach resonances in this mixture. The measurement of these resonances is of great interest for the precise investigation of the molecular potential. We have been able to observe 28 resonances in ten different spin combinations. Together with results from molecular spectroscopy, this allowed for a large improvement of the interaction model. One of the observed resonances is used for the production of weakly bound heteronuclear Feshbach molecules. The collisional stability of these molecules can be enhanced significantly by removing residual Rb atoms.

We report on the production of ultracold Feshbach molecules and the ongoing steps towards a deexcitation of such molecules into deeply bound molecular states via a Stimulated Raman Adiabatic Passage.

Q 60.7 Fr 12:30 3G/H

Correlated Tunneling of Few Bosons in a 1-D Double Well — •Sascha Zöllner[1], Hans-Dieter Meyer[1], and Peter Schmelcher[1,2] — [1]Universitaet Heidelberg, Theoretische Chemie, Im Neuenheimer Feld 229, 69120 Heidelberg — [2]Universitaet Heidelberg, Physikalisches Institut, Philosophenweg 12, 69120 Heidelberg

This talk is about few-boson tunneling in a one-dimensional double-well trap, covering the full crossover from weak interactions to the fermionization limit of strong correlations. After reviewing the underlying mechanism of ground-state fermionization of trapped bosons, it will be shown how the tunneling of two atoms evolves from Rabi oscillations to correlated pair tunneling as we increase the interaction strength. The physics behind it will be analyzed, rounded off by an outlook on how many-body effects modify the picture and how the tunneling can be controlled via tilting the wells.

Q 60.8 Fr 12:45 3G/H

A coherent single atom shuttle between two Bose-Einstein condensates — •Uwe R. Fischer[1], Christian Iniotakis[2], and Anna Posazhennikova[3] — [1]Institut für Theoretische Physik, Universität Tübingen, Auf der Morgenstelle 14, D-72076 Tübingen, Germany — [2]ETH Zürich, Institut für Theoretische Physik, CH-8093 Zürich, Switzerland — [3]Physikalisches Institut, Universität Bonn, D-53115 Bonn, Germany

We study an atomic quantum dot representing a single hyperfine "impurity" atom which is coherently coupled to two well-separated Bose-Einstein condensates, in the limit when the coupling between the dot and the condensates dominates the inter-condensate tunneling coupling. It is demonstrated that the quantum dot by itself can induce coherent oscillations of the particle imbalance between the condensates, which display a two-frequency behavior. For noninteracting condensates, we provide an approximate solution to the coupled nonlinear equations of motion which allows us to obtain these two frequencies analytically.