A 17: Ultra-cold atoms, ions and BEC IV (with Q)

Time: Wednesday 16:30–18:00 Location: BAR 205

A 17.1 Wed 16:30 BAR 205

Quantum dynamics of strongly interacting bosonic mixture.

— •Budhaditya Chatterjee[1], Ioannis Brouzos[2], and Peter Schmelcher[2] — [1]Physikalisches Institut, Universität Heidelberg, Philosophenweg 12, 69120 Heidelberg, Germany — [2]Zentrum für Optische Quantentechnologien, Luruper Chaussee 149, 22761 Hamburg, Germany

We look at tunneling dynamics of strongly correlated bosonic mixture. The effect of the inter- and the intra-species interaction and their interplay is investigated using the numerically exact Multi-Configuration Time dependent Hartree (MCTDH) method. Dynamics is calculated for two initial configurations- complete population imbalanced state and phase separated state. Increasing the inter-species interaction leads to an exponential increase in the tunneling time period analogous to the quantum self-trapping for condensates. The increase of the intra-species repulsion elongates the tunneling period for small inter-species correlations while in the opposite case of stronger interaction it enhances the tunneling. These effects are explained by studying the spectra and the stationary states. The effect of higher particle number as well as number symmetry is discussed.

A 17.2 Wed 16:45 BAR 205

Atomic homodyne detection of two mode squeezed states —

•Helmut Strobel, Christian Gross, Eike Nicklas, Tilman Zibold, Jiri Tomkovic, and Markus K Oberthaler — Kirchhoff Institute for Physics, University of Heidelberg, Germany

In quantum optics homodyning is a very successful and widely used measurement technique that reveals the quadratures of the electric field. Its counterpart for Quantum Atom Optics, the measurement of the quadratures of a matter wave field, has not been realized so far. Here we present a homodyne measurement of the matter wave quadratures of two mode squeezed atomic quantum states produced by spin changing collisions in a Bose-Einstein condensate. Our measurements reveal strong correlation between the two largely occupied modes and show the existence of a non-vanishing pair phase, i.e. pair coherence. The observed noise level in the two mode quadratures is below the threshold expected for classical states and hence flags entanglement in the system.

A 17.3 Wed 17:00 BAR 205

Observation of new Feshbach Resonances in Sodium-Lithium Mixtures —

•Tobias Schuster, Raphael Scelle, Arno Trautmann, Steven Knoop, and Markus K. Oberthaler — Kirchhoff Institut für Physik, Universität Heidelberg, Im Neuenheimer Feld 227, 69120 Heidelberg

We report on studies of Feshbach resonances in an ultracold Bose-Fermi mixture of ^{23}Na and ^{6}Li. The experimentally observed spectra of resonances cover magnetic fields of more than 2kG and different spin channels. Our findings are explained in terms of the Asymptotic Bound-state Model, which gives a comprehensive explanation of our experimental results, differing substantially from previous theoretical predictions [1]. Possible applications of this ultracold Bose-Fermi mixture are discussed.

[1] M. Gacesa, P. Pellegrini, and R. Cote, Phys. Rev. A **78**, 010701(R) (2008)

A 17.4 Wed 17:15 BAR 205

Spinor Bose-Einstein condensates in optical superlattices —

•Andreas Wagner and Christoph Bruder — University of Basel

We examine spinor Bose-Einstein condensates in optical superlattices theoretically using a Bose-Hubbard hamiltonian which takes spin effects into account. Assuming that a small number of spin-one bosons is loaded in an optical potential, we study single-particle tunneling which occurs when one lattice site is ramped up relative to a neighbouring site. Spin-dependent effects modify the tunneling events in a qualitative and a quantitative way. We use a double-well potential as a unit cell of a one-dimensional superlattice and a four-well square-shaped potential as a unit cell of a two-dimensional superlattice. Homogeneous and inhomogeneous magnetic fields lead to spin-flip transitions and various other effects. E.g. it is possible for the four-well potential to observe spin-ordered states and non-trivial tunneling events, i.e. events at which at one site the particle number increases although the potential energy increases simultaneously. Finally, we investigate the bipartite entanglement between single sites and the remainder of the system and construct states of maximal entanglement.

A 17.5 Wed 17:30 BAR 205

New Efimov resonances in an ultracold cesium gas —

•Alessandro Zenesini[1], Martin Berninger[1], Bo Huang[1,2], Stefan Besler[1], Hanns-Christoph Nägerl[1], Francesca Ferlaino[1], and Rudolf Grimm[1,2] — [1]Institut für Experimentalphysik, Universität Innsbruck, 6020 Innsbruck, Austria — [2]Institut für Quantenoptik und Quanteninformation, Österreichische Akademie der Wissenschaften, 6020 Innsbruck, Austria

Efimov trimer states represent the paradigm of universality in few-body physics. Although these exotic three-body weakly-bound states have been experimentally investigated in an increasing number of ultracold atomic systems, many fundamental aspects remain unclear [1]. An intriguing open question is related to how short-range physics influences the Efimov effect in real systems. Short range contributions are commonly included in universal theory via a single parameter, known as "three-body parameter". An open question is whether this parameter is constant or whether it can vary significantly when Feshbach resonances are employed for interaction tuning. Cesium is a very promising candidate to address this issue because of the many broad and narrow Feshbach resonances with different partial-wave character. Our experimental results reveal new Efimov features close to different Feshbach resonances and shed new light on the three-body parameter.

[1] "Forty years of Efimov physics: How a bizarre prediction turned into a hot topic" F. Ferlaino and R. Grimm, Physics 3, 9 (2010)

A 17.6 Wed 17:45 BAR 205

Structural Defects in Ion Chains by Quenching the External Potential: The Inhomogeneous Kibble-Zurek Mechanism —

Giovanna Morigi[2], Adolfo Del Campo[1], Gabriele De Chiara[3], Martin Plenio[1], and •Alex Retzker[1] — [1]Universitaet Ulm, Ulm, Germany — [2]Universität des Saarlandes, Saarbrücken, Germany — [3]Universitat Autonoma de Barcelona, Barcelona, Spain

The nonequilibrium dynamics of an ion chain in a highly anisotropic trap is studied when the transverse trap frequency is quenched across the value at which the chain undergoes a continuous phase transition from a linear to a zigzag structure. Within Landau theory, an equation for the order parameter, corresponding to the transverse size of the zigzag structure, is determined when the vibrational motion is damped via laser cooling. The number of structural defects produced during a linear quench of the transverse trapping frequency is predicted and verified numerically. It is shown to obey the scaling predicted by the Kibble-Zurek mechanism, when extended to take into account the spatial inhomogeneities of the ion chain in a linear Paul trap.