A 36: Ultra-Cold Atoms, Ions and BEC V (with Q)

Zeit: Freitag 10:30–12:30 Raum: VMP 6 HS-C

Fachvortrag A 36.1 Fr 10:30 VMP 6 HS-C

Supersolidity in a commensurate mixture of one-dimensional hardcore bosons with mass imbalance — •Tassilo Keilmann[1], Ignacio Cirac[1], and Tommaso Roscilde[1,2] — [1]Max-Planck-Institut für Quantenoptik, Garching, Germany — [2]Ecole Normale Supérieure de Lyon, Lyon, France

We propose two methods to create a **superfluid solid phase** of an attractive mixture of mass-imbalanced hardcore bosons in a 1D optical lattice. At a commensurate filling with 2-to-1 filling ratio, we observe the formation of a crystal of *trimers* (made of two heavy and one light particle) which shows quasi-condensation and superfluidity for *both* particle species at the same time - hence a two-species supersolid. Supersolidity is observed both in the ground state of the system, as well as out of equilibrium in the stationary state that the system attains in the Hamiltonian evolution, that starts off initially from a crystal of trimers. These two situations correspond to two different preparation protocols (simple adiabatic loading into an optical lattice, and release from a superlattice) which can both lead to the direct observation of **supersolidity in optical lattices** using present experimental techniques.

Fachvortrag A 36.2 Fr 11:00 VMP 6 HS-C

Laser Cooling and Trapping of Barium — •Lorenz Willmann — KVI, University of Groningen, The Netherlands

The heavy alkaline earth element barium (Ba) offers no single closed optical transition. The strong $6s^2\ ^1S_0$ - $6s6p\ ^1P_1$ cooling transition at 553.7nm branches with 0.3% into three metastable states. This loss is 100 times larger than for the corresponding transition in the lighter earth-alkali strontium. Repumping was accomplished via the $6s6p\ ^1P_1$ state at the wavelengths 1108nm, 1130nm and 1500nm. A Ba atomic beam was slowed by light at the cooling and the repump wavelengths and then captured in a magneto optical trap (MOT). A collection efficiency of 1% from the atomic beam was achieved. The capture velocity of the MOT was 30(5) m/s. Three-photon photoionization from the ground state limited the trap lifetimes at higher cooling laser intensities. The multi-laser approach lead to coherent Raman transitions and a large fraction of 0.5(2) of the population in the metastable states. Several branching ratios and lifetimes of highly excited states have been determined, which provide input for atomic structure calculations.

The atomic level scheme of radium (Ra) is similar to Ba and the laser cooling and trapping approach can be transferred. Atomic Ra exhibits large enhancement factors for time reversal and parity violating effects, i.e permanent electric dipole moments (EDMs). The enhancements of up to four orders of magnitude are due to near degenerate states of opposite parity in the atomic and nuclear level structure. An experimental search for EDMs is underway at the TRIμP facility at KVI where short-lived Ra isotopes are available.

A 36.3 Fr 11:30 VMP 6 HS-C

Magnetism and Phase Transitions in High Temperature Superfluids — •Thomas Judd, Robin Scott, and Mark Fromhold — School of Physics and Astronomy, University of Nottingham, University Park, Nottingham, NG7 2RD, UK

Magnetism and strong inter-particle interactions are believed to play a significant role in high temperature superconductors but not in conventional BCS superconductors. Many unanswered questions remain about the nature of their influence. However, recent advances in cold atom physics allow us to investigate these long standing issues from a new angle by studying superfluidity in strongly interacting atomic Fermi gases. It is also possible to consider how long range magnetic interactions affect the superfluid state. Theoretical work on such systems is limited by their complexity - conventional computer resources struggle to model three-dimensional Fermi gases at finite temperature with strong interactions which can undergo phase transitions and exhibit coherence. However, by exploiting high performance computing resources, these difficulties can be overcome and new insights gained. Here we present progress towards simulations of high temperature superflow in fermionic systems with magnetic interactions and optical lattices. We use a beyond-mean-field wave-mechanical model which includes fluctuations and second-order scattering terms. The model reproduces unanticipated results observed in recent BEC-BCS crossover experiments and also temperature phase transitions. We have begun work investigating how magnetic dipolar interactions affect the dynamics of rotating Bose gases and the formation of vortex lattices.

A 36.4 Fr 11:45 VMP 6 HS-C

Temperature gradients in superfluid Bose-Hubbard systems — •Lukas Gilz and James Anglin — Fachbereich Physik, TU Kaiserslautern, 67663 Kaiserslautern

While the interaction of Bose-Einstein-Condensates (BEC) with homogeneous thermal environments has been studied extensively, and phenomena such as condensate growth and decoherence have been well understood, little attention has been payed to the interaction of BECs with inhomogeneous environments. We examine non-equilibrium steady states of cold bosons tunneling between a finite series of potential wells, while interacting at opposite ends of the series with two distinct particle reservoirs, characterized by different temperatures and chemical potentials. We describe the coherent dynamics of the system with a Bose-Hubbard Hamiltonian, and model the interaction with the thermal reservoirs using a quantum kinetic master equation. We derive expressions for the temperature gradient and heat current in the system, in various dynamical regimes.

A 36.5 Fr 12:00 VMP 6 HS-C

Cooling and Trapping of metastable Magnesium — •Matthias Riedmann, Jan Friebe, André Pape, Temmo Wübbena, Ernst M. Rasel, and Wolfgang Ertmer — Institut für Quantenoptik, Leibniz Universität Hannover, 30167 Hannover

Magnesium is one of the few elements suitable for a neutral atom optical lattice clock. The magic wavelength is predicted between 430 and 470 nm and magnesium offers interesting features like low sensitivity to room temperature blackbody radiation, one of the main uncertainty contributions of state-of-the-art lattice clocks. Up to now, cooling of Mg atoms within the singlet system is limited to the mK regime.

We report on first results with a magneto-optical trap based on transitions in the triplet system. On this transition, the cooling is not limited by the Doppler theory and we expect to reach temperatures in the *K range which are necessary for efficient loading of optical dipole traps. We also use this MOT as an efficient, state-selective detector of atoms in a frequency-sensitive Ramsey-Borde interferometer.

A 36.6 Fr 12:15 VMP 6 HS-C

Optical traps for ultracold metastable helium atoms — •Juliette Simonet — LKB ENS, Paris, France

One of the main characteristics of metastable helium atoms is their high internal energy (20 eV). This energy can be released when a metastable atom hits a surface, ejecting one electron. Therefore, using a Channeltron Electron Multiplier (CEM), one can detect atoms with a time resolution of up to 5 ns. However, this high internal energy raises the problem of inelastic Penning ionizations, following: He*+ He* -¿ He + He+ + e*. This process has a rate of the order of 10*10cm3.s*1 but is reduced by four orders of magnitude if the atoms are spin polarized due to total spin conservation.

We report on the progess of the set up of a dipole trap for ultracold metastable helium using a red detuned fiber laser at 1560nm. One of the aims of this optical trap is to release the constraint on the magnetic field value. We plan to measure the magnetic field dependance of inelastic collision rates initially calculated by P. O. Fedichev1, for temperatures smaller than 10μK. In a spin polarized gas of helium, the spin-spin interaction produces spin relaxation and relaxation induced Penning ionization if the polarization condition is no longer maintained.

We also present the development of a optical lattices in 1D and later in 3D. We intend to monitor the Penning ionization rate in order to follow the real-time dynamics of the Superfluid-Mott insulator quantum phase transition.