A 7: Ultra-Cold Atoms: Manipulation and Detection (with Q)

Time: Tuesday 14:00–16:00 Location: A 320

A 7.1 Tu 14:00 A 320

Interactions of atoms with spatially dispersive solids — •Harald Haakh[1], Carsten Henkel[1], and Baruch Horovitz[2] — [1]Universität Potsdam, Germany — [2]Ben Gurion University of the Negev, Beer Sheva, Israel

We discuss the coupling of atoms and ions to solid surfaces, in particular superconductors and metals. This is relevant for the anomalous heating in miniaturized ion traps and for spin flip rates of magnetic traps implemented on microchips, which determine the trap stability. Our approach is based on the surface response of spatially dispersive media, relevant for vortex lattices in type-II superconductors and the anomalous skin effect. We identify in particular the relevance of the scattering mean free path of the carriers in the solid, as compared to the distance of observation by the atom. Different boundary conditions for the current density (specular vs. diffuse) are generalized to the relevant parameter regime (non-retarded transverse response).

A 7.2 Tu 14:15 A 320

A new Experiment for the investigation of ultra-cold Potassium Rubidium Mixtures — •Georg Kleine Büning, Johannes Will, Jan Peise, Wolfgang Ertmer, and Jan Arlt — Institut für Quantenoptik, Leibniz Universität Hannover, Welfengarten 1, 30167 Hannover

We present an experimental apparatus, which will allow us to investigate mixtures of ^{87}Rb with the bosonic isotopes of potassium ^{39}K or ^{41}K, and also enable the use of Feshbach-resonances.

In the experiment the desired isotopes are collected in a magneto-optical trap from the background vapour. A magnetic quadrupole trap is used to transport the pre-cooled atoms mechanically into a glass cell with better vacuum. There the atoms are transferred into a novel hybrid optical and magnetic trap. Subsequently sympathetic cooling will be used to bring the desired isotopes of rubidium and potassium to quantum degeneracy. Finally a magnetic field can be tuned to the Feshbach resonances to manipulate the interaction strength.

Particular attention will be given to the design of the novel hybrid trap, which recently allowed for the realisation of a BEC of about 10^6 ^{87}Rb atoms.

A 7.3 Tu 14:30 A 320

Evaporative cooling in a magnetic trap strongly distorted by gravitation — •Matthias Wolke, Julian Klinner, and Andreas Hemmerich — Universität Hamburg

Due to experimental constraints our cigar-shaped magnetic trap has to operate with its weak confinement along the direction of gravity. We present the first Bose-Einstein-Condensate via RF-induced evaporative cooling in this scenario. Differences between this setup and the conventional setup with its weak trapping axis in the horizontal direction are discussed. In our setup different Zeeman-species display a macroscopic difference in gravitational sag. We present data, which show that this has significant impact on the evaporation efficiency.

A 7.4 Tu 14:45 A 320

Collective atom-cavity effects with cold Ytterbium gases. — Matteo Cristiani[1], Hannes Gothe[1], Tristan Valenzuela[1], and •Jürgen Eschner[1,2] — [1]ICFO - Institut de Ciencies Fotoniques, Mediterranean Technology Park, 08860 Castelldefels (Barcelona), Spain — [2]FR Experimentalphysik, Universität des Saarlandes, Campus E2.6, 66123 Saarbrücken

We report results from an experiment aiming at collective dynamics of a cold atomic ensemble coupled to the mode of an ultra-high finesse Fabry-Perot cavity. In our experiment we cool and trap $\approx 10^6$ Yb atoms in a MOT using the $^1S_0 \rightarrow {}^1P_1$ transition at 399 nm. The cloud temperature is $T = 2\,\mathrm{mK}$. Around the cloud position we have set up a high finesse cavity with length $L = 4.74\,\mathrm{cm}$, linewidth $\kappa = 2\pi \times 60\,\mathrm{kHz}$ and finesse $\mathcal{F} = 55000$. We study the action of the atomic cloud on the cavity mode and observe a behaviour which indicates the presence of strong collective atom-photon coupling. The effects of the cavity mode on the atomic dynamics (cavity cooling and self-organization) are under investigation.

A 7.5 Tu 15:00 A 320

Matter Wave Scattering from Ultracold Atoms in an Optical Lattice — Scott N. Sanders[1,2], •Florian Mintert[3], and Eric J. Heller[1] — [1]Physics Department, Harvard University — [2]Massachusetts Institute of Technology — [3]Physikalisches Institut, Albert-Ludwigs-Universität Freiburg

We study matter wave scattering from an ultracold, many body atomic system trapped in an optical lattice. The angular cross section of the target lattice for a matter wave is determined and is demonstrated to have a strong dependence on the many body phase, superfluid or Mott insulator. Analytical approaches are employed deep in the superfluid and Mott insulator regimes, while intermediate points in the phase transition are treated numerically. Matter wave scattering offers a convenient method for non-destructively probing the quantum many body phase transition of atoms in an optical lattice.

A 7.6 Tu 15:15 A 320

Towards phase damping of two independent condensates via an optical high finesse cavity — •Simone Bux, Christine Gnahm, Gordon Krenz, Claus Zimmermann, and Philippe A.W. Courteille — Physikalisches Institut Tübingen, Auf der Morgenstelle 14, 72076 Tübingen

Optical ring cavities have been proposed for novel optical cooling schemes for atoms and molecules known as "cavity-cooling" [1,2]. However, they also play an important role in the quest for controllable damping mechanisms working even for superfluids, whose prominent feature is the absence of friction. Our goal is to experimentally prove the viability of a cavity-based damping scheme predicted to lead to the unification of independently grown Bose-Einstein condensates (BEC) [3]. For this purpose, we create in our experiment two BECs of Rb87 in two different hyperfine states. The states are coherently driven on a microwave-radiofrequency two-photon transition and additionally coupled by a Raman transition, which is stimulated by a high-finesse ring cavity. This scheme induces an irreversible cycling in the atomic excitation and, due to the cavity-mediated coupling to the external degrees of freedom, a synchronization of the condensates' de Broglie phases. We will present the model and the state of the art of our experiment.

[1] V. Vuletic and S. Chu, Phys. Rev. Lett. 84, 3787 (2000)
[2] P. Horak, S. M. Barnett, and H. Ritsch, Phys. Rev. A 61, 033609 (2000)
[3] D. Jaksch, S. A. Gardiner, K. Schulze, J. I. Cirac, and P. Zoller, Phys. Rev. Lett. 86, 4733 (2001)

A 7.7 Tu 15:30 A 320

Dissipative manipulation of an ultracold quantum gas — •Andreas Vogler[1,2], Peter Würtz[1], Tatjana Gericke[1], Tobias Weber[1,2], Fabian Etzold[1], Frank Markert[1], and Herwig Ott[1,2] — [1]Institut für Physik, Johannes-Gutenberg Universität, Mainz — [2]Fachbereich Physik, Technische Universität Kaiserslautern

We present an experimental investigation of dissipative effects, affecting a cloud of ultracold Rb-atoms.

In our experiment we ionize atoms of an atomic ensemble by electron-impact ionization, using a tightly focussed electron-beam. The ions are extracted by means of electrostatic optics and subsequently detected. This allows us to probe density distributions with high spatial resolution. Furthermore, the electron-beam is a versatile tool capable of applying particle dissipation on the atomic ensemble. We can vary the atomic losses on individual positions by controlling the dwell time. By choosing the correct scan-pattern we are able to perturb the atomic cloud either on distinct places or homogeneously.

The temporal analysis of the detected ions allows us to determine cross-sections of electron-atom scattering as well as observe signatures of cold ion-atom collisions. We propose this dissipative manipulation technique to study many-body effects, e.g., local and non-local particle-particle correlations.

A 7.8 Tu 15:45 A 320

A New Apparatus for Cavity QED Experiments in the Strong Coupling Regime — •Markus Koch, Christian Sames, Matthias Apel, Max Balbach, Alexander Kubanek, Alexei Ourjoumtsev, Pepijn Pinkse, Karim Murr, and Gerhard Rempe — Max-Planck-Institut für Quantenoptik, D-85748 Garching, Germany

The ability to trap single atoms in high-finesse cavities in the strong coupling regime has stimulated the field of cavity QED, leading to the observation of many long predicted effects such as the normal-mode splitting, two-photon resonances or cavity cooling. We present the status of a new apparatus to continue this line of research.

It features an asymmetric cavity, which significantly enhances the photon flux from the cavity. In addition, coned mirrors provide transverse optical access to the trapped atom. Finally, a piezo motor allows to adjust the length of the cavity macroscopically, thus enabling to study cavity QED effects over a broad range of cavity parameters.

First measurements of the normal modes as well as of the intensity response of the system are presented. We observe considerably increased storage times compared to previous experiments, mandatory for further investigations, e.g. nonlinear optics at the single-particle level.