A 14: Poster I - Ultra-cold atoms, ions and BEC

Zeit: Dienstag 16:30–18:30 Raum: Poster B

A 14.1 Di 16:30 Poster B

Transportable Rubidium magneto-optical trap as a high precision target for highly charged ions — •Simone Götz, Magnus Albert, Judith Eng, Terry Mullins, Wenzel Salzmann, Roland Wester, and Matthias Weidemüller — Physikalisches Institut, Universität Freiburg, Hermann Herder Str.3, D-79104 Freiburg i. Br.

A transportable magneto-optical trap for rubidium atoms is presented which serves as a high precision target with high densities for ion beams and photons. In scattering experiments with highly charged ions the low temperature of the target atoms ($< 100\mu K$), corresponding to very low momentum spreads of the rubidium atoms ($\delta p < 0.01$), ensures a high resolution measurement of the recoil ion momentum components using Recoil-Ion-Momentum Spectroscopy (RIMS) [1]. The setup will be tested with multiphoton ionization experiments in strong ultrashort laser pulses. Adding photon and x-ray detectors and performing time-coincidence measurements, the process of double and triple electron transfer from the target atoms to the projectile atoms can be investigated in detail. Resonance phenomena are expected to be observed.

[1]S. Vajda *et al.* Chem.Phys. 267, 231-239,(2001)

A 14.2 Di 16:30 Poster B

Rydberg atom in a Bose-Einstein condensate — •Stephan Middelkamp[1], Peter Schmelcher[1,2], and Igor Lesanovsky[3] — [1]Theoretische Chemie, Institut für Physikalische Chemie, Universität Heidelberg, INF 229, D-69120 Heidelberg, Germany — [2]Physikalisches Institut, Universität Heidelberg, Philosophenweg 12, D-69120 Heidelberg, Germany — [3]Institute of Electronic Structure and Laser, Foundation for Research and Technology Hellas, P.O. Box 1527, GR-71110 Heraklion, Greece

We present a new method of determening characteristic paramenters of a Bose-Einstein condensate via spectroscopy of the electronic excitation levels of one of the condensate's atoms. We calculated the energy levels of a Rydberg atom embedded in a Bose-Einstein condensate for different trapping potentials. These energy levels depend on characteristic parameters of the Bose-Einstein condensate. Therefore one can gain information about the Bose-Einstein condensate by determening the electronic excitation levels of the Rydberg atom via spectroscopy.

A 14.3 Di 16:30 Poster B

Superradiant Rayleigh scattering in a high finese ring cavity — •Gordon Krenz, Sebastian Slama, Simone Bux, Claus Zimmermann, and Philippe Courteille — Physikalische Institut, Eberhard-Karls-Universität Tübingen, Auf der Morgenstelle 14, D-72076 Tübingen, Germany

We study the collective interaction of light with ultracold rubidium atoms. We are interested in the sudden build-up of a reverse light field in a laser-driven high-finesse ring cavity filled with ultracold thermal or Bose-Einstein-condensed atoms. While superradiant Rayleigh scattering from atomic clouds is normally only observed at very low temperature (1 μK), the presence of a ring cavity enhances cooperativity and allows for superradiance with thermal clouds as hot as several 10 μK. A characterization of the superradiance at various temperature and cooperativity parameters allows us to link it to the collective atomic recoil laser (CARL).

A 14.4 Di 16:30 Poster B

Thomas-Fermi approximation for a BEC in an optical dipole trap — •Walter Strunz and Lena Simon — Physikalisches Institut, Universität Freiburg, Hermann-Herder-Str. 3, 79104 Freiburg

Motivated by an experiment in the Helm group at the University of Freiburg, we study a Bose-Einstein condensate in an optical dipole trap. On the basis of the Thomas-Fermi theory we obtain analytical expressions valid beyond the usual harmonic approximation. We determine relevant condensate properties and compare with the exact solution of the Gross-Pitaevskii equation. Finally we focus on the release dynamics as studied in the experiment.

A 14.5 Di 16:30 Poster B

Thermal dephasing of a Bose- Einstein Condensate in a double well potential — Walter Strunz and •Sigmund Heller — Physikalisches Institut, Universität Freiburg, Hermann- Herder- Straße 3 79104 Freiburg i. Br.

Our primary goal is a thorough understanding of the phase of a Bose-Einstein- condensate in a double well potential. Within a two mode model [1,2] we calculate the phase classically and quantum mechanically and compare it with experimental results of the Oberthaler group (Heidelberg University)[3]. The ground state and first excited state are obtained by a 3D imaginary time propagation.

In order to consider the influence of additional states we introduce a new stochastic Gross- Pitaevskii equation for finite temperature that provides the canonical ensemble on average. We discuss properties of this Langevin equation.

[1] L. Pitaevskii and S. Stringari. Phys. Rev. Lett. 87.180402 (2001).

[2] D. Ananikan and T. Bergemann. Phys. Rev. A 73.013604 (2006).

[3] R. Gati, B. Hemmerling, J. Foelling, M. Albiez and M. K. Oberthaler. Phys. Rev. Lett. 96.130404 (2006).

A 14.6 Di 16:30 Poster B

EIT-based cooling of neutral atoms — •Maryam Roghani and Hanspeter Helm — Department of molecular and optical physics, Stefan-Meier-Str. 19,D-79104 Freiburg,Germany

The concept of EIT has recently been discussed as a means of cooling neutral trapped atoms [1]. We attempt to evaluate this scheme under using realistic parameters as they are present in an optical dipole trap for Rb atoms and discuss the potential sensitivity of the cooling scheme using a realistic multi-level atom. Specifically we wish to address likely limitations in the applicability of the EIT scheme for neutral atom traps. Such limitations arise from a variety of reasons. Among these are: a) the low vibrational frequencies of atoms in dipole traps, b) the effect of anharmonicities (these appear naturally from the intensity profile of the laser beam but also due to the gravitational potential and the mean field of interaction), c) the substantial difference in vibrational frequencies for ground and excited state atoms (unless the trap is operated at a magic wavelength for which the AC-Stark shifts of ground and excited state are identical), d) the sensitivity of the scheme to residual magnetic fields and to fluctuations of the laser fields, e) the necessity of an artificially introduced spatial dependence of the transistion dipole moment in order to enforce off-diagonal vibrational transitions. [1]. F. Schmidt - Kaler, J. Eschner, G. Morigi, C. F. Roos, D. Leibfried, A. Mundt, R. Blatt, Laser cooling with electromagnetically induced transparency: application to trapped samples of ions or neutral atoms. Appl. Phys. B 73, 807 (2001).

A 14.7 Di 16:30 Poster B

Study of the Born-Oppenheimer Approximation for Mass-scaling of Cold Collision Properties — •Stephan Falke, Eberhard Tiemann, and Christian Lisdat — Institut für Quantenoptik, Leibniz Universität Hannover, Welfengarten 1, 30167 Hannover

Ultracold collisions of atoms are often described by the s-wave scattering length. Also, positions and widths of Feshbach resonances characterize these collisions. Full information about the scattering wavefunctions is given by interaction potential curves, which can be determined by molecular spectroscopy. Adding neutrons to one of the nuclei does not alter the potential curve (Born-Oppenheimer approximation, BOA). It is possible to derive eigenvalues, Feshbach resonances, and the scattering length for different isotope combinations from a single potential simply by changing the reduced mass if the BOA is fulfilled. We study the validity of the BOA for asymptotic levels of the potential curve describing the A $^1\Sigma_u^+$ state [1] of K_2 (correlated to the $4s_{1/2}+4p_{1/2}$ asymptote) by comparing spectra of the two isotopomers $^{39}K_2$ and $^{39}K\,^{41}K$ obtained by high resolution laser spectroscopy in a molecular beam.

[1] J. Chem. Phys. **125**, 224303 (2006).

A 14.8 Di 16:30 Poster B

An electrodynamic trap for neutral atoms — •Sophie Schlunk[1,2], Adela Marian[1], Allard Mosk[3], Peter Geng[1], Wieland Schöllkopf[1], and Gerard Meijer[1] — [1]Fritz-Haber-Institut, Berlin, Germany — [2]FOM-Institute for Plasmaphysics Rijnhuizen, Nieuwegein, The Netherlands — [3]University of Twente, Enschede, The Netherlands

We are implementing an AC electric trap for atoms, which has been proposed by Peik [Eur. Phys. J. D 6, 179 (1999)]. The predicted potential-well depths for Rb atoms are on the order of 15 μK. It has been shown that polar molecules can be trapped in such an AC electric trap [PRA 74, 063403 (2006)]. Electrodynamic trapping of Sr atoms has also been demonstrated on an atom chip [PRL 96, 123001 (2006)].

The basic idea behind our AC trap is to create an electric field configuration that has a saddle point of constant field strength at the center of the trap and slopes of opposite signs in the axial and radial directions. Switching between the two electric field configurations gives confinement in 3D, by generating an alternately focusing and defocusing force in each direction.

In the experiment, the Rb atoms are cooled in a standard MOT loaded from a Zeeman slower. After loading the atoms in a magnetic trap, a density on the order of 10^{11} atoms/cm^3 and a temperature of about 100 μK are measured. Next, the cold Rb cloud is transferred to a second vacuum chamber by physically moving the magnetic trap. This second vacuum chamber houses the AC trap.

At the meeting we will report on our latest results.

A 14.9 Di 16:30 Poster B

All-Optical Realization of a Bose-Einstein Condensation in a Dipole Trap — •Christoph Käfer, Riad Bourouis, Jürgen Eurisch, Maryam Roghani, and Hanspeter Helm — Department of Molecular and Optical Physics, Stefan-Meier-Straße 19, 79104 Freiburg, Germany

We trap up to $3 \cdot 10^8$ ^{87}Rb atoms in a conventional 3D-MOT, which is fed from a high pressure 2D-MOT source. The 3D-MOT overlaps spatially with the tight focus of a 27 Watt CO_2 laser (initial trap frequencies: $v_r = 2400$ Hz, $v_z = 160$ Hz). The loading of the dipole trap is accomplished in a 60 ms molasses phase with strongly detuned trap laser beams. After transferring about 1 % of the atoms into the dipole trap, we start a phase sequence, where forced evaporation leads to a cold sample of atoms within 5-9 s. Optimizing the last step, a Bose-Einstein Condensate of typically 30000 atoms at densities exceeding $2 \cdot 10^{13}$ atoms/cm^3 is formed. We discuss the technical setup and give a detailed characterization of the trapped gas throughout the experimental cycle as well as effects of inhomogeneous magnetic fields.

A 14.10 Di 16:30 Poster B

Eine neue Apparatur für Fermionen in einer optischen Mikrofalle — •Timo Ottenstein[1], Friedhelm Serwane[1] und Selim Jochim[1,2] — [1]Max-Planck-Institut für Kernphysik, Heidelberg — [2]Fakultät für Physik und Astronomie, Universität Heidelberg

Für ein neuartiges Experiment mit wenigen fermionischen Atomen in einer optischen Mikrofalle bauen wir eine neue Apparatur auf. Ausgangspunkt für die Experimente soll ein Bose-Einstein-Kondensat von $^6Li_2$-Molekülen sein, das auf etablierte Weise in einer optischen Dipolfalle erzeugt wird. Ein entscheidender Vorteil eines solchen Kondensats ist die Einstellbarkeit der Wechselwirkung zwischen den ^{6}Li-Atomen, die so weit reicht, dass das Kondensat in ein superfluides Gas von wechselwirkenden Fermionen konvertiert werden kann (BCS-Gas). Ein solches Kondensat wird in eine stark fokussierte optische Mikrofalle transferiert, die eine Größe von wenigen Mikrometern hat. Das Potential dieser Mikrofalle lässt sich durch Absenken der Intensität so genau kontrollieren, dass nur noch wenige Quantenzustände in der Falle lokalisiert sind. Das lässt sich ausnutzen, um gezielt alle Atome aus der Falle auszuschütten bis auf die Teilchen, die sich in den wenigen noch gebundenen Zuständen der Falle befinden. Über den Fortschritt des experimentellen Aufbaus wird berichtet