Q 50: Poster Ultrakalte Atome

Zeit: Donnerstag 16:30–19:00 Raum: Poster C2

Q 50.1 Do 16:30 Poster C2

Trapping and guiding neutral atoms using ultra-thin optical fibres. — •Guillem Sagué, Eugen Vetsch, Florian Warken, and Arno Rauschenbeutel — Institut für Physik, Staudingerweg 7, 55128 Mainz

We aim to optically trap and guide neutral atoms close to the surface of subwavelength-diameter optical fibres. For this purpose, we set up a two-colour surface trap which is based on light-induced dipole forces exerted on the atoms by a blue- and red-detuned evanescent light field [1], created by launching two co-propagating laser beams through the fibre. This results in a cylindrically symmetric trap around the fibre. It exhibits a trapping minimum about two hundred nanometers above the surface with expected radial trapping frequencies above 700 kHz. By launching a second, counter-propagating red-detuned laser beam through the fibre a red-detuned standing wave can be realized. This results in a periodic trapping potential along the fibre, thereby confining the atoms in all three dimensions.

[1] G. Sagué, E. Vetsch, W. Alt, D. Meschede, and A. Rauschenbeutel, Phys. Rev. Lett. **99**, 163602 (2007)

Q 50.2 Do 16:30 Poster C2

Optical Spectroscopy On Trapped Nanoparticles — •Alexander Kuhlicke, Stefan Schietinger, and Oliver Benson — AG Nano-Optik, Institut für Physik, Humboldt-Universität zu Berlin, Hausvogteiplatz 5-7, 10117 Berlin

Linear radio frequency ion traps, so-called Paul traps, became widely used tools for high-resolution spectroscopy because of the absent interaction between particles and supporting surfaces or other particles. With their help it was possible to build up quantum registers and implement first operations for quantum computing. Also trapping of micrometer-sized particles in larger traps was demonstrated. Until today not much work was done for trapping particles in the span between these two size regimes of few atoms and microscopic particles. We have narrowed the gap by trapping single nanoparticles with sizes down to 20 nm within a linear Paul trap. We observed Coulomb crystals within the trap and performed spectroscopy on single trapped dye-doped particles and N-V centers in nanodiamonds. Future experiments aim at the spectroscopy of single quantum emitters revealing their interaction with a mesoscopic environment.

Q 50.3 Do 16:30 Poster C2

Lasersystem zum Kühlen und Fangen von neutralem Quecksilber — •Patrick Villwock, Arne Schönhut, Mathias Sinther und Thomas Walther — TU Darmstadt, Institut für Angewandte Physik, AG Laser und Quantenoptik, Schlossgartenstr.7, 64289 Darmstadt

Kalte Quecksilberatome in einer magneto-optischen Falle bieten die Möglichkeit der Erzeugung translatorisch kalter Moleküle durch Photoassoziation, sowie deren Laserkühlung in den vibratorischen Grundzustand. Zusätzlich erlaubt es die Untersuchung eines neuen Zeitstandards. Quecksilber hat stabile bosonische und fermionische Isotope, deren natürliche Häufigkeit im zweistelligen Prozentbereich liegen. Die Sättigungsintensität des Kühlübergangs bei 253,7 nm beträgt 10,2 mW/cm^2 bei einer natürlichen Linienbreite von 1,27 MHz.

Die Strahlung bei dieser Wellenlänge kann durch zweimalige Frequenzverdoppelung erreicht werden. Als Basis dient ein Yb:YAG Scheibenlaser der am Rand seines Verstärkungsmaximums bei 1014,8 nm betrieben wird. Die erste Verdopplungsstufe bildet ein geheizter LBO innerhalb eines Überhöhungsresonators. Als zweite Verdopplungseinheit folgt ein kommerzieller Überhöhungsresonator mit einem temperaturstabilisierten BBO. UV-Leistungen über 200 mW können so erreicht werden.

Q 50.4 Do 16:30 Poster C2

Clock laser for an optical lattice clock with strontium — •Thomas Legero, Fritz Riehle, and Uwe Sterr — Physikalisch-Technische Bundesanstalt, Braunschweig, Germany

Ultrastable lasers with high spectral purity are a key technology in optical frequency metrology. We report on a 698 nm master-slave diode laser setup to probe the 1S0 - 3P0 clock transition of strontium atoms confined in a 1D optical lattice. The master laser is an extended cavity diode laser in Littman configuration which is locked to a high finesse optical cavity by the Pound-Drever-Hall stabilization technique. The temperature-stabilized and vibration-insensitive cavity is made of a 100 mm long ULE spacer and shows a Finesse of 330 000. For probing the clock transition, the light from the injection locked slave laser is sent to the strontium atoms and to a femtosecond fiber-laser comb by two actively noise-cancelled optical fibers. We present the setup and the characteristics of the master-slave system and the performance of the fiber noise cancellation.

Q 50.5 Do 16:30 Poster C2

Vorbereitende Experimente zu einer magnetooptische Falle für Erbium — •Riad Bourouis, Benjamin Botermann und Martin Weitz — Universität Bonn, Institut für Angewandte Physik, 53115 Bonn, Deutschland

Wir zeigen, wie wir eine magnetooptische Falle für Erbium realisieren wollen. Die optischen Eigenschaften von Erbium werden präsentiert. Insbesondere erklären wir den Aufbau einer Erbium-Gasentladungszelle, mit deren Hilfe wir eine Spektroskopie zur Stabilisierung eines kommerzielles Lasersystem betreiben. Außerdem stellen wir Planung, Aufbau und Konzept eines Zeeman-Slowers vor. Dabei gehen wir speziell auf die Vereinbarkeit von theoretischer Vorarbeit und experimenteller Umsetzung ein. Wir berichten über aktuelle Fortschritte des Experiments.

Q 50.6 Do 16:30 Poster C2

Ion trap for efficient single ion-photon coupling — Robert Maiwald[1,2], •Markus Sondermann[1], Gerd Leuchs[1], James C. Bergquist[2], Dietrich Leibfried[2], Joe Britton[2], and David J. Wineland[2] — [1]Institut für Optik, Information und Photonik, Max Planck Forschungsgruppe, Universität Erlangen-Nürnberg, 91058 Erlangen, Germany — [2]National Institute of Standards and Technology, Boulder, CO 80305, USA

We present the design of an ion trap that allows for the localization of an ion in the focal point of a deep parabolic mirror. The trap consists of a single radio frequency (RF) electrode and two ground electrodes. The RF electrode and one of the ground electrodes are placed concentrically on the optical axis of a conducting parabolic mirror that establishes the second ground electrode. This geometry results in a trapping potential that follows the axial symmetry of parabolic mirrors. Furthermore, the trap design enables minimally invasive optical access to the ion from almost the entire solid angle. The latter property is essential for efficient coupling of single ions to single photons in free space.

The trap design can be adapted for other applications by replacing the mirror by a planar electrode. Using this more general design the ion can still be optically accessed from at least half to over 90% of the solid angle. First test results are presented.

Q 50.7 Do 16:30 Poster C2

Ultra-cold Strontium atoms in 1-D optical lattice for optical frequency metrology — •Joseph Sundar Raaj Vellore Winfred, Thomas Legero, Christian Lisdat, Fritz Riehle, and Uwe Sterr — Physikalisch-Technische Bundesanstalt, Braunschweig, Germany

Recent advancement in optical frequency metrology promises to measure time with a fractional accuracy of 10^{-17}. Such precise measurement of time is very important in technological and scientific endeavors. With a narrow transition linewidth of about 1 mHz and the existence of the magic wavelength in the NIR region for optical traps leading to cancellation of AC stark shift of the clock transition, strontium is an attractive candidate for such an optical clock. We report preliminary results of our Strontium optical clock experiment. ^{88}Sr atoms are cooled down to ultra cold temperature regime($\sim 1\ \mu$K) and trapped in a 1-D optical lattice with a potential depth around 120 μK. Details of our experimental set up, characterization of atoms in the 1-D optical lattice with respect to different trap parameters and the status of spectroscopy of the magnetic field induced $^1S_0$-$^3P_0$ clock transition will be presented.

Q 50.8 Do 16:30 Poster C2

Chromium atoms in a very deep optical trap — •Jimmy Sebastian, Anoush Aghajani-Talesh, Markus Falkenau, Axel Griesmaier, and Tilman Pfau — 5. Physikalisches Institut, Universität

Stuttgart

We study the properties of a very deep (∼4mK) optical dipole trap for ultracold chromium atoms that is generated by a single 300W fibre laser at a wavelength of 1070nm. We load the dipole trap directly from a magneto optical trap. Due to the high intensity of the laser field, the atoms in the region of the dipole trap experience differential light shifts between ground state and excited state much larger than the line width of the cooling transition. Additionally, the shifts depend on the polarization of the dipole trap beam and on the magnetic states which strongly influences the cooling and loading mechanism in the trap.
We present spectroscopic measurements and calculations of the differential shifts and discuss strategies for optimal loading of optical traps in such a regime.

Q 50.9 Do 16:30 Poster C2

Ladedynamik optischer Dipolfallen bei Erdalkaliatomen — •Felix Vogt, Joseph Sundar Raaj Vellore Winfred, Uwe Sterr und Fritz Riehle — Physikalisch-Technische Bundesanstalt, Bundesallee 100, D-38116 Braunschweig

Vorgestellt wird die experimentelle Untersuchung des Transfers von Atomen aus einer magnetooptischen Falle in eine optische Dipolfalle für die Erdalkaliatome ^{40}Ca und ^{88}Sr. Beide Elemente werden in einer zweistufigen magnetooptischen Falle auf ∼12 μK (Ca) und ∼1 μK (Sr) abgekühlt und in eine optische Dipolfalle umgeladen. Als Dipolfallenlaser dient für Ca ein 25 W Yb:YAG-Scheibenlaser (1030 nm) und für Sr ein 1,1 W Ti:Sa-Laser (813 nm). Das durch das Lichtfeld des Dipolfallenlasers erzeugte Potential des Grund- (^{1}S$_0$) und angeregten Zustands (^{3}P$_1$) ist attraktiv, weist jedoch, abhängig von der Wellenlänge des Dipolfallenlasers eine unterschiedliche Tiefe für die atomaren Zustände auf. Dies beeinflusst die Effizienz der Laserkühlung innerhalb der Dipolfalle und damit auch die Laderate. Wir beobachten ein dynamisches Gleichgewicht im Transfer der Atome zwischen Dipol- und magnetooptischer Falle, das durch ein Differentialgleichungsmodell gut beschrieben werden kann. Maximale Transferraten werden bei übereinstimmender Tiefe von Grund- und angeregtem Zustand erwartet. Der Einfluss des geometrischen Überlapps zwischen beiden Fallen auf die Laderate wird zusätzlich diskutiert und die optimalen Transferbedingungen für Ca und Sr miteinander verglichen.

Q 50.10 Do 16:30 Poster C2

Atom guiding in a photonic band gap fibre — •Stefan Vorrath, Sönke Möller, Kai Bongs, and Klaus Sengstock — Universität Hamburg, Institut für Laser-Physik, Hamburg, Germany

In our project we investigate a promising new kind of atomic waveguide based on a 2D photonic band gap fibre which provides nearly lossless guiding of light and atoms in the central hole over long distances. Our guiding mechanism is realized by capturing, compressing and cooling rubidium atoms from a dark spot MOT into the guiding trap composed of several watts of laser power at 1064nm. After optimizing the loading process of our trap we capture about 3 million atoms in front of the fibre. Our newest results will be presented.

Q 50.11 Do 16:30 Poster C2

Status of the Hamburg Cavity Cooling Experiment — •Julian Klinner, Malik Lindholdt, Matthias Wolke, and Andreas Hemmerich — Institut für Laserphysik, Universität Hamburg, Hamburg, Germany

We prepared a new experimental apparatus, which permits to trap a Bose-Einstein Condensate of rubidium atoms inside an optical cavity with 500.000 finesse and a mode volume greater than 0.1 cmm. The cavity displays a ratio between the scattering rate into the cavity mode and into all other modes well above 10 and a narrow bandwidth of a few kHz. We plan to explore cavity induced cooling mechanisms in the transition regime between thermal and quantum degenerate atomic dynamics. The poster presents the status of our experiments.

Q 50.12 Do 16:30 Poster C2

CO2-Laser Optical Dipole Trap for Fermionic Potassium Atoms — •Alexander Gatto, Christian Bolkart, Sylvi Händl, and Martin Weitz — Institut für Angewandte Physik, Rheinische Friedrich-Wilhelms-Universität Bonn, Wegelerstrasse 8, 53115 Bonn, Deutschland

All optical techniques for the cooling of atoms toward quantum degeneracy are especially attractive for fermions, since in contrast to most magnetic trap techniques no additional atomic species for sympathetic cooling are required here. We here report on ongoing work aiming at an all-optical preparation of a 40K Fermi gas in a CO2-laser dipole trap, which will be used for the study of strongly correlated Fermi gases in optical lattices. Initially, we load a magneto-optical trap of 40K atoms from a two-dimensional MOT. Subsequently, the atomic density is increased in a compressed MOT, for which the magnetic field gradient is ramped towards higher values. Our CO2-laser dipole trap realized by a single mid-infrared focussed beam is loaded from this ensemble of cold atoms, in which further cooling by means of evaporative cooling will be performed. The present status of the work will be reported.

Q 50.13 Do 16:30 Poster C2

Continuous loading of calcium atoms into an optical dipole trap — •Purbasha Halder, Chih-Yun Yang, Oliver Appel, Dirk Hansen, and Andreas Hemmerich — Institut für Laserphysik, Universität Hamburg, Luruper Chaussee 149, 22761 Hamburg

Alkaline-earth metals are interesting candidates for novel laser cooling schemes due to the presence of narrow intercombination lines in addition to strong principal fluorescence lines. We demonstrate an efficient scheme for continuously loading Ca atoms into a ground-state ($^1S_0$) optical dipole trap (ODT) at 532nm. The ODT is loaded from a MOT in the triplet metastable state ($^3P_2$), by spatially selective optical pumping. This is done by careful superposition of the dipole trap laser on a depumping laser at 430 nm.

With this setup we achieve a cold ensemble of 10^5 atoms at 40 μK and a phase space density of $4 \cdot (10^{-5})$. The loading and subsequent evaporation and cross-dimensional relaxation stages are well described by a simple model. We also point out that a comparable scheme could be employed to load a dipole trap with $^3P_0$ atoms.

We are now setting up a new dipole laser at 1064 nm. We will be trying out a crossed dipole trap with which we hope to achieve efficient evaporative cooling and eventually reach quantum degeneracy. Here, we present the latest developments and the current status of our experiment.

Q 50.14 Do 16:30 Poster C2

Development and Characterization of a Multiple Species Zeeman Slower — Ryan Olf, Edward Marti, Enrico Vogt, •Anton Öttl, and Dan Stamper-Kurn — Department of Physics, University of California, Berkeley, CA 94720

An increasing number of experiments cool and trap multiple atomic species both simultaneously and alternatively. Here we present a Zeeman slower design which is optimized for multiple species operation. Different sections of precision windings are targeted at individual species, with only marginally reduced performance than a slower designed for a single species only.

We have constructed a Zeeman slower that is optimized for Lithium and Rubidium atoms emerging from a dual species oven. A combined Lithium-Rubidium magneto-optical trap is loaded with the slowed atomic beam. We will review design and construction of the setup and characterize the dual species operation of our system.

Q 50.15 Do 16:30 Poster C2

Imaging ultracold atoms with nanometer resolution — •Tim Langen, Tatjana Gericke, Peter Würtz, Daniel Reitz, and Herwig Ott — Institut für Physik, Johannes Gutenberg-Universität, 55099 Mainz

We present our experimental setup for high resolution imaging of individual atoms in ultracold quantum gases. The apparatus combines scanning electron microscopy with a standard all-optical approach to Bose-Einstein condensation of ^{87}Rb. A condensate of up to 120000 atoms is produced inside a CO_2 laser dipole trap 13 mm below the tip of an electron microscope. The focused 6 keV electron beam scanning through the cloud of atoms is able to locally produce ions that are subsequently detected with a channeltron ion detector. This allows a precise reconstruction of the atoms' initial positions only limited by the width of the electron beam. We demonstrate the resolving power by imaging single sites of an optical lattice with a period of 604 nm.

Q 50.16 Do 16:30 Poster C2

Fringe-free imaging of BEC with spatially incoherent light — •Jochen Kronjäger[1], Lars Neumann[1], Christoph Becker[1], Kai Bongs[2], and Klaus Sengstock[1] — [1]Institut für Laser-Physik, Universität Hamburg — [2]Midlands Centre for Ultracold Atoms, University of Birmingham

Imaging techniques of cold atomic gases, e.g. alkali Bose-Einstein condensates, critically rely on one atomic absorption line with a width of a few MHz typically. Laser light from the same source used for e.g. Doppler cooling naturally provides the highly concentrated spectral power density needed for efficient absorption or phase contrast imaging. The drawback of using laser illumination in any application is interference fringes, originating from diffraction at optical apertures or dust particles and multiple reflections on optical surfaces in the light path.

We have developed and tested an approach to neutralize these unwanted artefacts which is based on laser light scattered from an opaque fluid. In a simplified view, random scattering destroys the spatial coherence of the beam, while preserving its spectral narrowness. A more refined approach based on the properties of laser speckle allows to quantitatively analyze our setup and demonstrates its fitness for the purpose of fringe reduction.

Q 50.17 Do 16:30 Poster C2

Methods for High-Resolution Preparation of Bose-Einstein Condensates with Spatial Light Modulators — •Simon Stellmer, Mathis Baumert, Christoph Becker, Parvis Soltan-Panahi, Jochen Kronjäger, Kai Bongs, and Klaus Sengstock — Institut für Laserphysik, Uni Hamburg, Germany

The use of Spatial Light Modulators (SLM) has developed into a common technique in the past years. The field of application ranges from biological use in the form of optical tweezers to optical manipulation of Bose-Einstein condensates. Splitting and transport of BECs [1] has been demonstrated, as well as the generation of oscillating solitons [2] and the observation of Josephson junctions in ultra-cold atoms [3].

Here we present a method to manipulate BECs with an extraordinary high spatial resolution, leading e.g. to the generation of solitons in Bose-Einstein condensates. We achieve the accuracy by imaging computer generated structures on a spatial light modulator onto the BEC.

Additional preparation methods are discussed regarding resolution and feasibility. We present holographic imaging in divergent laser beams allowing for an optical set-up with extremely high numerical aperture and therefore high resolution. Furthermore, we report on the possibilities of generating non-diffractive Bessel beams which may be employed in transport of atoms within quantum registers and atom guiding within photonic band gap fibres.

[1] V. Boyer *et al.*, Phys. Rev. A **73**, 031402 (2006)
[2] C. Becker *et al.*, to be published
[3] S. Levy *et al.*, Nature **449**, 579 (2007)

Q 50.18 Do 16:30 Poster C2

State-selective microwave potentials on atom chips — •Pascal Böhi[1,2], Max F. Riedel[1,2], Johannes Hoffrogge[1,2], Theodor W. Hänsch[1,2], and Philipp Treutlein[1,2] — [1]Max-Planck-Institut für Quantenoptik, Garching — [2]Fakultät für Physik, Ludwig-Maximilians-Universität München

We present the status of our experiment with microwave near-fields on atom chips. Microwave near-fields are a key ingredient for atom chip applications such as quantum information processing, entanglement of Bose-Einstein condensates, atom interferometry, the study of Josephson effects and chipbased atomic clocks. We have integrated miniaturized microwave guiding structures on our atom chip. The micrometersized structures allow to generate microwave near-fields with unusually strong gradients. Through microwave dressing of hyperfine states, these can be used to create state-selective double-well potentials.

Q 50.19 Do 16:30 Poster C2

An ultracold gas of Rydberg atoms — •Wendelin Sprenger, Christoph Hofmann, Janne Denskat, Christian Giese, Thomas Amthor, and Markus Reetz-Lamour — Physikalisches Institut Universität Freiburg, Hermann-Herder-Str.3, 79104 Freiburg

We report on the investigation of interaction phenomena in ultracold Rydberg gases. ^{87}Rb atoms are confined in a magneto-optical trap and excited into Rydberg levels via a two-photon process (780 nm and 480 nm). We present experimental details and results of the latest work. This includes coherent Rabi oscillations between ground and Rydberg state [1] and stimulated rapid adiabatic passage, transferring 90% of the gas into Rydberg states [2], ionization induced by van der interatomic forces, even for systems initially exhibiting repulsive v.d.W. interaction [3,4] and the understanding of the coherent dynamics of resonant energy transfer processes [5] . We also present a proposal for studying energy transport in the presence of exciton traps [6] and for structuring the Rydberg gas.

[1] M. Reetz-Lamour *et al.*, submitted
[2] J. Deiglmayr *et al.*, Opt. Comm. 264, 293 (2006)
[3] T. Amthor *et al.*, Phys. Rev. Lett. 98, 023004 (2007)
[4] T. Amthor *et al.*, Phys. Rev. A 76, 054702 (2007)
[5] S. Westermann *et al.*, Eur. Phys. J. D 40, 37 (2006)
[6] O. Mülken *et al.*, Phys. Rev. Lett. 99, 090601 (2007)

Q 50.20 Do 16:30 Poster C2

Apparatus for all optical probing of Rydberg states — •Harald Kübler, Tim Van Boxtel, Stefan Müller, Robert Löw, and Tilman Pfau — 5. Physikalisches Institut, Universität Stuttgart, Pfaffenwaldring 57, 70550 Stuttgart, Germany

We present an apparatus for all optical probing of Rydberg states in a dense atomic sample, trapped in a crossed CO_2 laser trap. We implemented electrical field control which allows us to apply complex field configurations on the atoms.

The apparatus offers an excellent numeric aperture for the detection of Rydberg states via light (in contrast to detection via field ionization). For this we will use electromagnetically induced transparency on the usual 5S-5P absorption line via coherent coupling to a highly excited Rydberg state[1]. We present first Rydberg EIT experiments.

[1] A. K. Mohapatra, T. R. Jackson, C. S. Adams: Coherent optical detection of highly excited Rydberg states using electromagnetically induced transparency

Q 50.21 Do 16:30 Poster C2

State-Selective Transport of Single Caesium Atoms — •Leonid Förster, Michał Karski, Daniel Döring, Florian Grenz, Arne Härter, Wolfgang Alt, Jai-Min Choi, Artur Widera, and Dieter Meschede — Institute for Applied Physics, University of Bonn

The state-selective quantum transport of single neutral atoms in optical lattices offers a promising alternative to implement basic modules of advanced schemes in the context of quantum engineering. These range from the implementation of so called quantum walks, utilizing fundamental quantum effects involving spatial quantum interference to the preparation of so-called cluster states using coherent cold collisions as an inter-qubit interaction.

We investigate systems of single Caesium atoms stored, one by one, in a state-dependent one-dimensional optical lattice. It is formed by a superposition of two standing wave dipole traps with right- and left-handed circular polarisation respectively. They can be shifted with respect to each other. With an appropriate wave length, each of the two lattices couples to a different hyperfine state. Therefore, atoms prepared in these qubit states can be transported in opposite directions. Using microwave pulses in the presence of magnetic field gradients, the internal states can be separately manipulated.

We present the current state of the experimental realisation of a one-dimensional quantum transport for Caesium atoms, focussing on the experimental setup and the tools for the preparation and manipulation of individual qubit states and their spatial detection.

Q 50.22 Do 16:30 Poster C2

Measuring the coupling strength of single atoms to the field of a high-finesse optical resonator — •Tobias Kampschulte, Wolfgang Alt, Mkrtych Khudaverdyan, Karim Lenhard, Sebastian Reick, Karsten Schörner, and Dieter Meschede — Institut für Angewandte Physik, Wegelerstr. 8, D-53115 Bonn

Cavity QED experiments provide unique possibilities for studying atom-photon interactions at a fundamental level. In our experiment we investigate the coupling of a small number of neutral caesium atoms to the mode of a high-finesse optical cavity ($\mathcal{F} = 10^6$).

Using a number-triggered loading process we transfer a predetermined number of atoms, ranging from a single atom to several atoms, from a magneto-optical trap into a standing wave dipole trap. Subsequently, the atoms are transported into the center of the cavity mode with submicrometer precision using the dipole trap as an optical conveyor belt.

Of fundamental importance for the implementation of any controlled atom-cavity interaction is the knowledge of the atom-cavity coupling strength $g(\vec{r})$. It is equivalent to the energy splitting of the cavity mode when an atom is present. The splitting can be measured by taking a transmission spectrum of a weak probe laser beam going through the cavity. A different approach is the detection of the change of the atomic state induced by the probe laser when it is resonant with a mode of the coupled atom-cavity system.

The controlled and deterministic coupling of single atoms to the mode of a cavity is an important step towards cavity-enhanced atom-atom interaction, a basic ingredient of quantum information processing.

Q 50.23 Do 16:30 Poster C2

Manipulation of a quantum particle in a rapidly oscillating potential by phase hops — Armin Ridinger[1] and •Christoph Weiss[1,2] — [1]Laboratoire Kastler Brossel, École Normale Supérieure, Université Pierre et Marie-Curie-Paris 6, CNRS — [2]Institut für Physik, Universität Oldenburg

We show that the state and the energy of a quantum particle trapped by a rapidly oscillating potential can be significantly manipulated in a controlled fashion by instantaneously changing the phase of the potential (a phase hop). We demonstrate our results for the case of the ideal one-dimensional Paul-trap.

Q 50.24 Do 16:30 Poster C2

Spectroscopy of two-photon resonances in a single-atom-cavity system — •Alexander Kubanek, Ingrid Schuster, Andreas Fuhrmanek, Thomas Puppe, Pepijn Pinkse, Karim Murr, and Gerhard Rempe — Max-Planck-Institut für Quantenoptik, Hans-Kopfermann-Str. 1, 85748 Garching

Strong coupling of a single atom to a single mode of an optical cavity leads to an energy level structure consisting of a ladder of doublets, the lowest of which is known as the normal-mode splitting. Here we show additional resonances in the transmission spectrum stemming from multi-photon transitions to higher doublets, which exhibit a nonlinear response to a change of probe intensity. To explain the details of the spectra, we need to take into account the micromotion of the atom which is localized in the mode by means of an auxiliary intracavity dipole trap. For this reason, we perform Monte-Carlo simulations on the dynamics of a trapped atom in a driven cavity. We calculate atomic trajectories by combining the Langevin equation of motion for the atom's center of mass with the internal dynamics of a two-state atom coupled to a quantized mode. In this way, we are able to match theory and experiment. Additionally, we show that a classical treatment of the field following Maxwell's equations fails to reproduce the data, regardless of whether the atom is modelled as a harmonic oscillator or as a two-state particle. This shows that the observed nonlinearity cannot be attributed to saturation effects, but is of quantum origin.

Q 50.25 Do 16:30 Poster C2

A freely falling magneto-optical trap drop tower experiment — •Thorben Könemann[1], Hansjörg Dittus[1], Tim van Zoest[2], Ernst Maria Rasel[2], Wolfgang Ertmer[2], Wojciech Lewoczko-Adamczyk[3], Achim Peters[3], Anika Vogel[4], Kai Bongs[4], Klaus Sengstock[4], Endre Kajari[5], Reinhold Walser[5], and Wolfgang Peter Schleich[5] — [1]ZARM, University of Bremen — [2]IQO, Leibniz University of Hanover — [3]QOM, Humboldt-University of Berlin — [4]Institute of Laser-Physics, University of Hamburg — [5]Institute of Quantum Physics, University of Hamburg

We experimentally demonstrate the possibility of preparing ultracold atoms in the environment of weightlessness at the earth-bound short-term microgravity laboratory Drop Tower Bremen. Our approach is based on a freely falling magneto-optical trap (MOT) drop tower experiment performed within the ATKAT collaboration (Atom-Catapult) as a preliminary part of the QUANTUS pilot project (Quantum Systems in Weightlessness) pursuing a Bose-Einstein condensate (BEC) in microgravity at the drop tower. We give a complete account of the specific drop tower requirements and present the results of the realized freely falling MOT and further accomplished experiments during several drops.

Q 50.26 Do 16:30 Poster C2

An Internet Controlled BEC Experiment — •Nadine Meyer, Anika Vogel, Kai Bongs, and Klaus Sengstock — Institut für Laserphysik, Universität Hamburg, Germany

In our project we present the fascinating world of cold atoms and Bose-Einstein condensation to students all over the world. In the experiment all relevant parameters including laser locking, laser power monitoring are internet controllable. The setup has only little need of maintenance, as we use the laser system designed in our QUANTUS collaboration (talk Q22.7) and an atom chip for a compact setup. In addition to a theoretical introduction to the field, there are animations and simulations for the users to work on. The project is funded by the Multimedia Kontor Hamburg.