A 23: Ultracold Atoms: Trapping and Cooling 1 (with Q)

Time: Thursday 14:30–16:00 Location: SCH A118

A 23.1 Thu 14:30 SCH A118

Experiments on atoms trapped in a two-color-dipole trap — •Rudolf Mitsch[1], Daniel Reitz[1], Melanie Müller[1], Samuel T. Dawkins[2], and Arno Rauschenbeutel[1] — [1]Technische Universität Wien - Atominstitut, Stadionallee 2, A-1020 Wien — [2]Johannes Gutenberg-Universität Mainz, AG QUANTUM, D-55099 Mainz

Our recent results on trapping laser-cooled cesium atoms around a subwavelength-diameter optical nanofiber will be presented. The atoms are localized in a dipole trap formed by a two-color evanescent field surrounding the optical nanofiber. The atoms are detected by sending a weak resonant probe beam through the nanofiber that couples to the atoms via the evanescent field. We can observe the light-matter-coupling by either measuring the absorption or the phase shift experienced by the probe light. Furthermore, we demonstrate that the off resonant measurements are non-destructive with respect to the number of trapped atoms. Finally, we present first results on Autler-Townes state splitting and electromagnetically induced transparency. These results open the route towards the manipulation and storage of light with coherently prepared fiber-coupled atomic ensembles. Potential applications include fiber-coupled quantum memories and quatum repeaters as well as many-body physics with light-matter quasi-particles.

Financial support by the Volkswagen Foundation, the ESF and the FWF Doctoral Programme CoQuS is gratefully acknowledged.

A 23.2 Thu 14:45 SCH A118

AC-Stark shift and photoionization of Rydberg atoms in an optical dipole trap — •Tobias Weber[1], Frank Markert[1], Peter Würtz[1], Andreas Koglbauer[2], Tatjana Gericke[1], Andreas Vogler[1], and Herwig Ott[1] — [1]Fachbereich Physik, Universität Kaiserslautern — [2]Institut für Physik, Universität Mainz

We present the measurement of the AC-Stark shift of the $14D_{5/2}$ Rydberg state of rubidium 87 in an optical dipole trap formed by a focussed CO_2-laser. We find good quantitative agreement with the model of a free electron experiencing a ponderomotive potential in the light field. In order to reproduce the observed spectra we take into account the broadening of the Rydberg state due to photoionization and extract the corresponding cross-section.

A 23.3 Thu 15:00 SCH A118

EIT cooling of an atom in optical resonators — •Marc Bienert and Giovanna Morigi — Theoretische Quantenphysik, Universität des Saarlandes, 66041 Saarbrücken, Germany

We consider a single, harmonically trapped atom in an optical resonator. The internal level configuration of the atom is Λ-shaped. One of the dipole transitions is coupled to a strong laser field, whereas the other transition interacts with the quantised light field of the optical resonator. The resonator is additionally pumped by a weak probe laser. Similar configurations have been used recently to demonstrate electromagnetically induced transparency of a single atom [1]. We investigate the mechanical effects of the radiation acting on the atomic motional degree of freedom. The analysis is performed in the Lamb-Dicke limit. We investigate several cooling mechanisms occurring in this configuration, among them an analog to EIT cooling in free space and cavity sideband cooling. Further cooling schemes which rely on quantum interference can be identified. Finally, we compare our findings with experimental results which show alternating cooling and heating areas around two-photon resonance [2].

[1] M. Mücke et al., Nature **465**, 755 (2010)
[2] T. Kampschulte et al., Phys. Rev. Lett. **105**, 153603 (2010)

A 23.4 Thu 15:15 SCH A118

Trapping ions with lasers — •Cecilia Cormick and Giovanna Morigi — Theoretische Physik, Universität des Saarlandes, D-66041 Saarbrücken, Germany

This work theoretically addresses the physics underlying the trapping of an ionized atom with a single valence electron by means of lasers. In our model, the coupling between the ion and the electromagnetic field includes the charge monopole and the internal dipole, within a multipolar expansion of the interaction Hamiltonian. Specifically, we perform a Power-Zienau-Woolley transformation, taking into account the motion of the center of mass. The net charge produces a correction in the atomic dipole which is of order m_e/M with m_e the electron mass and M the total mass of the ion. With respect to neutral atoms, there is also an extra coupling to the laser field which can be approximated by that of the monopole located at the position of the center of mass. These additional effects, however, are shown to be very small compared to the dominant dipolar trapping term, and we can conclude that the effect of the net charge on dipolar trapping is negligible.

A 23.5 Thu 15:30 SCH A118

Quantum jumps triggered by atomic motion — Mauricio Torres[1], •Marc Bienert[1,2], Stefano Zippilli[3,4], and Giovanna Morigi[2,3] — [1]Instituto de Ciencias Físicas, Universidad Nacional Autónoma de México, Cuernavaca, Morelos, Mexico — [2]Theoretische Quantenphysik, Universität des Saarlandes, 66041 Saarbrücken, Germany — [3]Departament de Física, Universitat Autònoma de Barcelona, E 08193 Bellaterra, Spain — [4]Fachbereich Physik and research center OPTIMAS, Technische Universität Kaiserslautern, 67663 Kaiserslautern, Germany

We theoretically study the occurrence of quantum jumps in the resonance fluorescence of a trapped atom. In our approach the atom is laser cooled in a configuration of levels such that the occurrence of a quantum jump is associated to a change of the vibrational center-of-mass motion by one phonon. The statistics of the occurrence of the dark fluorescence period is studied as a function of the physical parameters and the corresponding features in the spectrum of resonance fluorescence are identified. We discuss the information which can be extracted on the atomic motion from the observation of a quantum jump in the considered setup.

A 23.6 Thu 15:45 SCH A118

Neuartige Transportoperationen in planaren und dreidimensionalen Paulfallen mittels variabler Radiofrequenzamplituden — •Andreas Kehlberger[1], Stefan Ulm[1], Georg Jacob[1], Todd Karin[2], Isabela Le Bras[2], Nikos Daniilidis[2], Hartmut Häffner[2], Ferdinand Schmidt-Kaler[1] und Kilian Singer[1] — [1]Institut für Physik, Johannes Gutenberg Universität Mainz, Staudinger Weg 7, 55128 Mainz, Germany — [2]Department of Physics, University of California, 366 LeConte Hall #7300, Berkeley, CA 94720-7300, USA

Bisherige Paulfallen sind in der Lage mittels variabler DC Potentiale Ionen und Ionenketten entlang einer Fallenachse zu positionieren und Ionenkristalle zu trennen. Mittels variabler Radiofrequenzamplituden können wir diese Operationen nun auf alle drei Dimensionen ausdehnen. Wir präsentieren optimierte planare[1] und drei dimensionale Fallengeometrien um Ionen auf eine genau definierte Position zu platzieren. Desweiteren erläutern wir numerische Methoden um entsprechende Kalkulationen durchzuführen. Die Methoden berücksichtigen experimentelle Vorgaben und sind in der Lage anhand der Felder die benötigten Radiofrequenz Spannungen und Ionentrajektorien für gewünschte Transportoperationen zu optimieren.

Refrences

1. T. Karin, I. Le Bras , A. Kehlberger , K. Singer , N. Daniilidis, H. Häffner, arXiv:1011.6116 (2010)