A 15: Poster I

Zeit: Dienstag 16:30–19:00 Raum: VMP 9 Poster

A 15.1 Di 16:30 VMP 9 Poster

Frequency comb spectroscopy of Hydrogen 1S-3S — •Elisabeth Peters[1], Sascha Reinhardt[1], Scott Diddams[2], Thomas Udem[1], and Theodor W. Hänsch[1] — [1]Max-Planck-Institut für Quantenoptik, Garching, Germany — [2]National Institute of Standards and Technology

Precise spectroscopy of atomic hydrogen allows us to test fundamental theories as the quantum electro dynamics (QED). Decades of precise comparisons with experiments have established this theory in physics. The comparison of the narrow 1S-2S transition frequency, which has reached the uncertainty of 1.4 parts in 10^{14}, and determination of the Rydberg constant and the Lamb shift are presently limited by the large uncertainty in the proton charge radius. To overcome this limitation we set up an experiment to measure the absolute frequency of the 1S-3S two photon transition at 205nm.
The required UV light at 205nm is generated by two successive resonant enhanced second harmonic generations (SHG) of a mode locked titanium sapphire laser. The spectrum of such a mode locked laser features equidistant frequency modes, which can be used for the high precision spectroscopy.

A 15.2 Di 16:30 VMP 9 Poster

Polarization and entanglement studies on the two-photon transitions in hydrogenlike ions — •Filippo Fratini[1,2], Stephan Fritzsche[2,3], and Andrey Surzhykov[1,2] — [1]Universität Heidelberg — [2]GSI Helmholtzzentrum für Schwerionenforschung GmbH — [3]Frankfurt Institute for Advanced Studies

During the last two decades entanglement and polarization studies on the two–photon emission from few–electron ions and atoms have attracted particular interest both in experiment and theory. While, however, most investigations in the past have dealt with low–Z atomic systems, much of today's interest is focused on the high–Z region. At the GSI facility in Darmstadt, for example, two–photon polarization experiments with highly–charged heavy ions are likely to be carried out in the next few years. In order to provide theoretical support for these experiments, we apply the density matrix formalism based on Dirac's relativistic equation in order to describe the polarization states of two emitted photons. By using such a formalism, we are able to analyze *correlations* between the linear polarization of the photons in the $2s_{1/2} \rightarrow 1s_{1/2}$ and $3d_{5/2} \rightarrow 1s_{1/2}$ decay of neutral hydrogen H as well as hydrogen–like Xe^{53+} and U^{91+} ions. For these ions, we analyze the non–dipole contributions to the polarization correlations and compare our results obtained within the fully relativistic and the electric dipole [1] approximations.
[1] T. Radtke, A. Surzhykov, and S. Fritzsche, PRA **77**, 002507 (2008).

A 15.3 Di 16:30 VMP 9 Poster

Absolute Determination of X-ray Transition Energies in S^{14+} and Ar^{16+} Ions — •Katharina Kubicek, Hjalmar Bruhns, Johannes Braun, José R. Crespo López-Urrutia, and Joachim Ullrich — Max-Planck-Institut for Nuclear Physics, Heidelberg, Germany

We report on relative and absolute high-precision wavelength experiments for H-like and He-like ions, performed at the Heidelberg Electron Beam Ion Trap (EBIT) using a flat crystal (Si-111) X-ray spectrometer. Our measurements resulted in $\lambda_w = 5038.695(74)\,$mÅ, or $E_w = 2460.641(32)\,$eV for the $1s2p\ ^1P_1 \rightarrow 1s^2\ ^1S_0$ resonance line (w transition) in S^{14+}. The error of only 13 ppm is a factor of ~ 3 smaller than the former most precise value for this transition energy. Our result for the Ar^{16+} w transition, $\lambda_w = 3949.066(8)\,$mÅ, or $E_w = 3139.583(6)\,$eV, has an even smaller uncertainty of only 2 ppm being 6 times more accurate than the most precise measurement in any He-like ion and to the present day a factor 2.5 better than any X-ray wavelength determinaton in HCIs ever reported. As expected, in both cases excellent agreement with theory is obtained. The Lyman-α_1 X-ray transition wavelength was used as calibration line.

A 15.4 Di 16:30 VMP 9 Poster

Towards Laser Spectroscopy of the Ground State Hyperfine Splitting in Lithium-like ^{209} Bi^{80+} — •Matthias Nothhelfer[1,2], Benjamin Botermann[1,2], Andreas Dax[3], Christopher Geppert[2], Volker Hannen[4], Thomas Kühl[2], Rodolfo Sánchez[2], Thomas Stöhlker[2], Christian Weinheimer[4], and Wilfried Nörtershäuser[1,2] — [1]Universität Mainz, Germany — [2]GSI Darmstadt, Germany — [3]CERN, Genève, Switzerland — [4]Universität Münster, Germany

Measurements of the hyperfine splitting (HFS) in H- and Li-like heavy ions can be used to test QED in extremly strong fields. Comparing the transition frequencies, one can eliminate the contribution of the nuclear magnetization distribution (Bohr-Weisskopf effect) and test QED calculations [1]. ^{209}Bi is the only isotope, which has the ground state hyperfine transitions of both the H-like and the Li-like ion in a range accessible for laser spectroscopy in traps. So far, measurements have been performed with a relative uncertainty of $1.6\cdot10^{-4}$ ($^{209}Bi^{82+}$) [2] and $6\cdot10^{-3}$ ($^{209}Bi^{80+}$) [P. Beiersdorfer, priv. comm.], respectively. We are preparing a collinear laser spectroscopic measurement of the HFS in $^{209}Bi^{80+}$ at the Experimental Storage Ring at GSI. This experiment tests QED calculations and facilitates measurements on trapped ions [3] with a potential uncertainty below 10^{-6}, which will test QED calculations on the level of a few percent.
[1] V. M. Shabaev *et al.*, PRL **86**, 3959 (2001)
[2] I. Klaft *et al.*, PRL **73**, 2425 (1993)
[3] W. Quint *et al.*, PRA **78**, 032517 (2008)

A 15.5 Di 16:30 VMP 9 Poster

Perspektive für ein Experiment zum Test der Speziellen Relativitätstheorie — •Benjamin Botermann[1], G. Huber[1], S. Karpuk[1], W. Nörtershäuser[1,4], C. Novotny[1], D. Bing[2], D. Schwalm[2], A. Wolf[2], G. Gwinner[3], C. Geppert[1,4], H.-J. Kluge[4], T. Kühl[4], T. Stöhlker[4], T. W. Hänsch[5], S. Reinhardt[5], G. Saathoff[5] und T. Udem[5] — [1]Johannes Gutenberg Universität Mainz — [2]MPI für Kernphysik, Heidelberg — [3]University of Manitoba, Winnipeg, Canada — [4]GSI Helmholtzzentrum für Schwerionenforschung, Darmstadt — [5]MPI für Quantenoptik, Garching

Durch laserspektroskopische Messungen an Ionenstrahlen in modernen Beschleunigeranlagen können die bislang präzisesten Messungen der Zeitdilatation der Speziellen Relativitätstheorie (SRT) realisiert werden. Am Experimentier-Speicherring des Helmholtzzentrums für Schwerionenforschung wurden entsprechende Experimente an metastabilen $^7Li^+$-Ionen durchgeführt. Die Ionen wurden auf 33,8 % der Lichtgeschwindigkeit beschleunigt, in und entgegengesetzt zu ihrer Flugrichtung mit Laserlicht angeregt und das Fluoreszenzlicht analysiert. Bei Vorgängerexperimenten am MPI für Kernphysik [1] konnte die SRT bei niedrigerer Ionengeschwindigkeit mit hoher Präzision bestätigt werden. Mit dem bisherigen Messaufbau für hohe Ionengeschwindigkeiten können Abweichungen von der SRT mit einer Obergrenze von $3\cdot10^{-7}$ ausgeschlossen werden. Der hier vorgestellte Aufbau hat das Potential die Empfindlichkeit um etwa zwei Größenordnungen zu verbessern.
[1] S. Reinhardt et.al. *Nat.Phys.* **3** (2007) 861.

A 15.6 Di 16:30 VMP 9 Poster

Tiefenauslese orts- und zeitauflösender planarer Halbleiterdetektoren zur Untersuchung hochenergetischer Röntgenstrahlung — •U. Spillmann[1,2], H. Bräuning[1], S. Hess[1,2], Chr. Kozhuharov[1], Th. Krings[3], R. Reuschl[1,2], D. Protic[3], S. Trotsenko[1,2] und Th. Stöhlker[1,4] — [1]AP, GSI, 64291 Darmstadt — [2]IKF, Goethe-Universität, 60438 Frankfurt am Main — [3]Semikon GmbH, 52428 Jülich — [4]PI, Ruprechts-Karls-Universität, 69120 Heidelberg

Strukturierte energieauflösende Halbleiterdetektoren eröffnen neuartige Methoden in der Röntgen-Spektroskopie. Weiterhin ermöglichen diese Systeme unter Ausnutzung des Compton-Effekts Aussagen über den Polarisationsgrad sowie die Lage des Polarisationsvektors von Röntgenstrahlung. Eine weitere wichtige Anwendung ist die hochpräzise Vermessung atomarer Übergangsenergien in Kristallspektrometerexperimenten. Hier wird neben der hervorragenden Energieauflösung eine deutlich gesteigerte Effizienz im Vergleich zu klassischen Schlitzsystemen, die einfache Dioden einsetzen, erreicht. Gegenstand der aktuellen Arbeiten ist die Analyse der geometrischen und elektronischen Responsefunktion eines beidseitig strukturierten 128x48-Streifendetektors aus hochreinen Germanium, mit dem Ziel neben der zweidimenionalen Ortsinformation auch die Tiefe des Wechselwirkungspunkts im Detektorkristall bestimmen zu können. Somit lassen sich einerseits Parallaxefehler beim Imaging korregieren andererseits kann der Nachweis des Compton-Prozesses in Hinblick auf Compton-

Imaging optimiert werden.

A 15.7 Di 16:30 VMP 9 Poster

Solid-state laser systems for photoionization, laser cooling and coherent manipulation of magnesium ions — •Daniel Nigg[1], Börge Hemmerling[1], Birgit Brandstätter[2], Lukas An der Lan[2], and Piet O. Schmidt[1] — [1]QUEST Institute for Quantum Metrology, Physikalisch-Technische Bundesanstalt and Leibniz University of Hannover, 38116 Braunschweig, Germany — [2]Institut für Experimentalphysik, Universität Innsbruck, Austria

The challenges of performing precision spectroscopy with metal ions such as Ti^+ and Fe^+ arising from their complex level structure can be overcome by sympathetically cooling such ions and mapping their states via quantum logic methods to a more accessible 'logic' ion.

This contribution focuses on the details of an all-solid state laser system for photoionization, laser cooling and coherent manipulation of magnesium ions, which are used for sympathetic cooling the ions of interest. A single fibre laser, which is frequency quadrupled using LBO and BBO crystals in combination with electro- and acousto-optical modulators provides all laser frequencies required for this task. The photoionization is implemented by frequency quadrupling a diode laser using a MgO-doped PPLN and a BBO crystal. This laser system is selective to the 1S-1P transition of neutral Mg at 285nm. The autoionizing excited state can then be excited into the continuum by the photoionization laser or the Doppler cooling laser for the magnesium ion.

A 15.8 Di 16:30 VMP 9 Poster

Fluorescence cascades in Xe II after autoionization of doubly excited neutral Xenon — •Witoslaw Kielich[1], Pascal Kerdelhué[1], Philipp Reiss[1], Irina Haar[1], Rainer Hentges[1], Philipp V. Demekhin[1,2], Ivan D. Petrov[2], Viktor L. Sukhorukov[2], and Arno Ehresmann[1] — [1]Institute of Physics University of Kassel, Heinrich-Plett-Str. 40, 34132 Kassel, Germany — [2]Rostov State University of Transport and Communications, 344038 Rostov-on-Don, Russia

Excitation of two-electron states in rare gas atoms with narrowband synchrotron radiation provides information for the analysis of electron interaction in atomic shells. The 5s/5p Xenon valence electrons, at room temperature and with a target cell pressure of 53.3μbar, were excited to doubly excited states in the energy range between 26.15eV and 26.35eV. They autoionize and populate singly ionized Xenon states which decay through a two step fluorescence cascade with the first decay in the visible spectral range and the second in the vacuum-ultraviolet. The florescence cascades were measured using the photon-induced fluorescence spectroscopy (PIFS) technique after extreme narrowband excitation at the BESSY II U125/2 10m-NIM beamline. The obtained partial fluorescence cross sections are analyzed in respect of their dependence as function of the exciting-photon energy.

A 15.9 Di 16:30 VMP 9 Poster

Compact and robust tunable cw narrowband near IR-VIS-UV source for high-resolution spectroscopy — •Sergey Vasilyev, Hans-Emanuel Gollnick, Alexander Nevsky, and Stephan Schiller — Institut für Experimentalphysik, Universität Düsseldorf, Universitätsstr 1, 40225 Düsseldorf, Germany

Recent advances in high power fiber laser technology and advent of quasi-phase-matched (QPM) nonlinear materials open new opportunities for development of compact and reliable laser sources for high-resolution spectroscopy.

We report on a narrowband tunable multi-wavelength laser source, designed for laser cooling of the Beryllium ions. The source is based on quintupling of narrowband tunable diode laser (ECDL), amplified to 10 W using the Er doped fiber amplifier. A chain of nonlinear crystals (PPLN, PPSLT, BBO) is used for conversion to the fifth harmonic. The source is turnkey and requires a minimum warm-up time and realignment. The unique feature of the source is tunable multi-wavelength output, spanning from IR to UV: 1540-1570 nm (4 W), 770-785 nm (4 W), 513-523 (1 W), 308-314 nm (1 mW). The UV output power can be further increased by a factor of 20-30 using an enhancement cavity or recently announced UV-capable QPM crystals.

We have performed Doppler-free spectroscopy of the hyperfine-structure components of the molecular iodine using the third harmonic output. These lines could serve for absolute frequency stabilization of the source, providing stable UV radiation e.g. for laser cooling of Beryllium ions.

A 15.10 Di 16:30 VMP 9 Poster

Nuclear Charge Radii Measurements of ^{7,9,10,11}Be with Laser Spectroscopy — •Monika Žáková[1], Zoran Andjelkovic[1], Klaus Blaum[4], Mark L. Bissell[5], Gordon W. F. Drake[6], Christopher Geppert[1,2,3], Magdalena Kowalska[8], Jörg Krämer[1], Andreas Krieger[1], Rainer Neugart[1], Rodolfo Sánchez[2], Ferdinand Schmidt-Kaler[7], Dirk Tiedemann[1], Zong Chao Yan[9], Deyan Yordanov[4], Claus Zimmermann[3], and Wilfried Nörtershäuser[1,2] — [1]Institut für Kernchemie, Universität Mainz, 55099 Mainz, Germany — [2]GSI, 64291 Darmstadt, Germany — [3]Institut für Physik, Universität Tübingen, 72076 Tübingen, Germany — [4]MPI für Kernphysik, D-69117 Heidelberg, Germany — [5]Instituut voor Kern- en Stralingsfysica, Katholieke Universiteit Leuven, 3001 Leuven, Belgium — [6]Department of Physics, University of Windsor, Windsor, Ontario, Canada, N9B 3P4 — [7]Institut für Quanteninformationsverarbeitung, Universitä t Ulm, 89081 Ulm, Germany — [8]CERN, CH-1211 Geneva 23, Switzerland — [9]Department of Physics, University of New Brunswick, New Brunswick, Canada E3B 5A3

The rms nuclear charge radii of ^{7,10,11}Be have been determined for the first time using frequency-comb based collinear laser spectroscopy online. Spectroscopy with two frequency-stabilized dye lasers and combination with recent precise atomic theory calculations allowed us to extract these charge radii. Of particular interest is the nuclear charge radius of ^{11}Be, where one of the neutrons is loosely bound to the ^{10}Be core and creates so called 'halo nucleus'. The obtained isotope shifts for the D_1 and D_2-lines and the corresponding charge radii are presented.

A 15.11 Di 16:30 VMP 9 Poster

Towards an optical lattice clock with ^{88}Sr — •Thomas Middelmann, Joseph Sundar Raaj Vellore Winfred, Christian Lisdat, Thomas Legero, Fritz Riehle, and Uwe Sterr — Physikalisch-Technische Bundesanstalt and Centre for Quantum Engineering and Space-Time Research QUEST, Bundesallee 100, 38116 Braunschweig, Germany

Optical clocks achieve a higher stability and lower systematic uncertainty than the current microwave clocks using a hyperfine transition of ^{133}Cs, that defines the SI second. Thus optical clocks might be used to redefine the SI second. A very promising candidate is strontium. The doubly forbidden $^1S_0 - {}^3P_0$ clock transition is weakly allowed in ^{87}Sr (linewidth ≈ 1.2 mHz) and can be induced by a magnetic field in ^{88}Sr. We trap ^{88}Sr atoms in a horizontal 1-D optical lattice, where the atoms are confined in the Lamb-Dicke regime to suppress motional effects. At present the highest contributions to the uncertainty of strontium lattice clocks are frequency shifts due to the environmental black body radiation and especially for bosonic ^{88}Sr collisional shifts. We have measured the influence of collisions on the clock transition and discuss implications for the operation of a clock. To precisely evaluate the black body shift, atoms will be transferred to a cryogenic environment. First tests of the mechanical setup will be presented.

A 15.12 Di 16:30 VMP 9 Poster

Laser source for spectroscopy of trapped highly charged bismuth ions — •Sebastian Albrecht, Norbert Herschbach, Gerhard Birkl, and the SPECTRAP collaboration — Institut für Angewandte Physik, Technische Universität Darmstadt, Schlossgartenstraße 7, D-64289 Darmstadt

Our objective is to investigate the ground state hyperfine splitting of highly charged ions. Unprecedented precision and accuracy will be achieved by applying high resolution laser spectroscopy to ions cooled and stored in a Penning trap. This experiment is carried out as part of the SPECTRAP collaboration at GSI within the HITRAP facility.

For highly charged $^{209}Bi^{82+}$ ions, transitions between hyperfine ground states can be excited using light at 243.9 nm. We prepared a laser source delivering 20 mW for spectroscopy of these transitions. The scheme we developed to control the laser frequency aims at an accuracy of 2 MHz with respect to an atomic transition used as reference.

A 15.13 Di 16:30 VMP 9 Poster

High-Precision Experiments on a Single Trapped Radium Ion — O. Boell, G.S. Giri, K. Jungmann, B.K. Sahoo, R.G.E. Timmermans, •O.O. Versolato, L.W. Wansbeek, and L. Willmann — KVI, University of Groningen, The Netherlands

A single, trapped radium ion is an ideal candidate for high precision experiments. Two Ra^+ experiments are under construction at KVI. Ultra-narrow transitions in radium ions provide an excellent basis for an all-optical, high-stability frequency standard, i.e. a clock. The off-the-shelf availability of semiconductor lasers for all necessary transitions is highly advantageous. In certain odd isotopes of radium, the nuclear electric quadrupole shift is absent. The same system and experimental hardware will be used to search for physics beyond the Standard Model of particle physics by measuring Atomic Parity Violation. This will serve as a low-energy test of the running of the electroweak mixing angle. Recent calculations have shown Ra^+ to be the superior candidate. Recently we have succeeded in the production and efficient slowing down of isotopes around ^{213}Ra at the AGOR cyclotron and the TRIμP facility of KVI. Progress has been made in the development of ion traps and in the laser set-up in a dedicated laser laboratory. Laser spectroscopy of the radium ion and the first ever trapping of this particle are planned in the near future.

A 15.14 Di 16:30 VMP 9 Poster

A high current electron beam ion trap for fast charge breeding — •Thomas Baumann, José Crespo López-Urrutia, and Joachim Ullrich — Max-Planck-Institut für Kernphysik, Heidelberg, Germany

A new high current electron beam ion trap (EBIT) is constructed at the MPIK Heidelberg. This machine will utilize an up to 5 A electron beam, which is strongly confined by a 7 T magnetic field, to produce and trap highly charged ions from almost any stable element. The electron beam energy will be adjustable between 100 eV and up to 200 keV, while the extremely high current density within the trap region will allow for fast charge breeding, which enables this EBIT to produce He-, H-like or bare ions of heavy elements in hundreds of ms. These ions can be studied by experiments using high resolution spectrometers in the visible, soft x-ray and x-ray spectral range. Furthermore the ions will be extracted out of the EBIT into other experiments like ion-surface interaction measurements, a reaction microscope to study collision dynamics or a penning trap for high precision mass spectrometry.

A 15.15 Di 16:30 VMP 9 Poster

Resonance of Electromagnetically Induced Absorption in Bichromatic Field for Hanle Setup — •Andrey A. Zhukov[1,2], Sergey A. Zibrov[3], Vladimir L. Velichansky[3], and Valery P. Yakovlev[2] — [1]Institut für Quantenphysik, Universität Ulm, D-89069 Ulm, Germany — [2]Departament of Theoretical Physics, Moscow State Engineering and Physics Institute, 115409 Moscow, Russia — [3]P.N. Lebedev Physical Institute RAS, 117924 Moscow, Russia

The analytic description of the electromagnetically inducied absorbtion (EIA) in the Hanle configuration for the atomic transition $F_g = 1 \leftrightarrow F_e = 2$ is given. It is shown that the absorbtion coefficient depends on the coherence between the marginal ground sublevels. The qualitative explanation of the narrow structure of EIA in weak magnetic field is also discussed. In the case of the backward field acting on the transition $F_g = 1 \leftrightarrow F_{e'} = 1$, the EIA resonance strongly depend on a power of the backward field. Due to the effective Λ-scheme increasing of the backward field magnitude leads to increasing of the absorption coefficient.

A 15.16 Di 16:30 VMP 9 Poster

Fundamental symmetries in ^{21}Na decay — D.J. van der Hoek, R. Hoekstra, K. Jungmann, •W.L. Kruithof, C.J.G. Onderwater, M. Sohani, L. Willmann, and H.W. Wilschut — KVI, University of Groningen, Groningen, The Netherlands

The β-ν correlations in β-decay allows searching for contributions that go beyond the V-A description of the Standard Model for the electroweak interaction. We are developing an experimental setup to measure correlations in the β-decay of ^{21}Na. By trapping the radioactive atoms, the recoiling nucleus (kinetic energy < 230 eV) can be measured in a reaction microscope in coincidence with the emitted β particle. The first step is to study β-ν correlations that allows to set limits on scalar and tensor contributions. By polarizing the parent nucleus it becomes possible to search for time reversal violation. The production and trapping of ^{21}Na has been accomplished. Details of the setup with a two laser system and the status of this phase of the program will be described.

A 15.17 Di 16:30 VMP 9 Poster

Laser Spectroscopy of atomic Radium — Alexander Groot, Klaus Jungmann, •Bodhaditya Santra, Lorenz Willmann, and Hans W. Wilschut — KVI, University of Groningen, The Netherlands

The heavy alkaline earth elements radium (Ra) offers a unique sensitivity to a parity and time reversal violating permanent electric dipole moments (EDM). In particular, Ra exhibits the largest known atomic enhancements factors for EDMs. The intrinsic sensitivity arises from the specific atomic and nuclear structure of Ra. All Ra isotopes with nuclear spin I are radioactive. The lifetimes are shorter than 15d. Several Ra isotopes are available at the TRIμP facility at KVI. For the exploitation of the sensitivity Ra atoms have to be collected in a neutral atom trap. The main laser cooling will be done on the strong $^1S_0$-$^1P_1$ transition at 482.7nm, similar to the laser cooling and trapping of the chemical homologue barium. Laser spectroscopy of the strong $^1S_0$-$^1P_1$ transitions will be presented. The light at this wavelength is provided by frequency doubling of a Ti:sapphire laser in a $KNbO_3$ crystal. Of particular interest is the decay branching of the excited state to the metastable D-states. Such measurements are indispensable input for current atomic structure calculations, which are necessary for the analysis of a EDM measurement using Ra.

A 15.18 Di 16:30 VMP 9 Poster

Laser excitation and light shifts of highly charged ions — •Octavian Postavaru, Zoltan Harman, and Christoph H. Keitel — Max-Planck-Institut für Kernphysik, Saupfercheckweg 1, 69117 Heidelberg

Recent developments in laser technology allow the probing of highly charged ions in the strong field and in the x-ray domain, providing one new insights into relativistic electron dynamics, nuclear and quantum electrodynamic effects [1,2]. The interaction of ions with the laser field leads to resonant excitation of the bound electrons and to dynamic shifts of the energy levels. We apply a relativistic description of the excitation process and the light shifts by means of the Dirac equation, as necessary in the case of higher nuclear charges and for transitions which are nonrelativistically forbidden. We investigate excitation schemes by which the accuracy of measurements can be significantly improved, leading to new physical findings. The results are relevant for experiments with at present and near-future laser systems like the FLASH [1] and the PHELIX [2] facilities.

[1] S.W. Epp, J.R. Crespo López-Urrutia, G. Brenner *et al.*, Phys. Rev. Lett. 98, 183001 (2007)

[2] P. Neumayer, R. Bock, S. Borneis *et al.*, Laser and Particle Beams 23, 385 (2005)

A 15.19 Di 16:30 VMP 9 Poster

An Optical Dipole Trap Target for a Reaction Microscope — •Renate Hubele, Michael Schuricke, Jochen Steinmann, Ganjun Zhu, Alexander Dorn, and Joachim Ullrich — Max Planck Institut für Kernphysik, Heidelberg, Germany

For a thorough understanding of atomic reactions high quality experimental data on fundamental quantum systems are indispensable. One of the most sophisticated tools to study atomic fragmentation processes is the Reaction Microscope (REMI), which allows for a coincident detection of the full vector momenta of all charged final state particles over a solid angle of up to 4π. In recent years the merging of REMI spectrometers with magneto optically trapped targets became popular (MOTRIMS). Among the most important benefits of this combination compared to the conventional setup using gas jets, are lower target temperatures in the mK-regime allowing for a improved momentum resolution and the possibility of accessing target species like lithium that are hardly produced in a supersonic expansion.

However, if electrons are also to be detected, MOTRIMS setups suffer from transient eddy currents induced by the rapid turn-off of the MOT fields, limiting the momentum resolution due to stray magnetic fields in the electron spectrometer.

Therefore, our new setup will combine for the first time a purely optical dipole trap (FORT) with a REMI. Since we are already successfully operating a MOTRIMS experiment, we are now implementing a FORT in order to perform fully differential studies of lithium double and triple ionisation by photon or electron impact.

A 15.20 Di 16:30 VMP 9 Poster

Towards Laser Spectroscopy on Lithium II — •Mariusz Semczuk[1,2], Guido Saathoff[1], Valentin Batteiger[1], Maximilian Herrmann[1], Sebastian Knünz[1], Hans Schuessler[3], Thomas Udem[1], and Theodor Hänsch[1] — [1]Max-Planck-Institut für Quantenoptik, Garching — [2]Institute of Experimental Physics, University of Warsaw — [3]Dept. of Physics, Texas A&M University, Texas

Simple atomic systems like hydrogen and helium have been subject to great interest as they allow for sensitive tests of Quantum Electrodynamics. Helium spectroscopy, in particular, has been considered as one way of determining an accurate value of the fine-structure constant. The constant α can be derived from the fit of a theoretical calculation of the He 2^3P level fine structure to measured values. While the fine structure has been measured to high accuracy [1], there is still a significant discrepancy between two theoretical calculations [2]. In order to help solve this open problem in bound-state QED, we plan to measure the 2^3P fine structure in helium-like Li^+. The lithium ion provides the advantage that it can be trapped and laser-cooled in an ion trap. Moreover the Li^+ fine structure is more sensitive to higher-order QED terms as these scale with large powers of Z. The measurement is complicated by hyperfine structure. We thus aim at a measurement of the complete hyperfine structure multiplet of the 2^3S_1-$2^3P_{0,1,2}$ optical transition in $^7Li^+$ to extract both the hyperfine and fine structure simultaneously.

[1] T. Zelevinsky, *et al.*, Phys. Rev. Lett. 95, 203001 (2005).
[2] G.W. F. Drake, Can. J. Phys. 80, 1195 (2002); K. Pachucki, Phys. Rev. Lett. 97, 013002 (2006)

A 15.21 Di 16:30 VMP 9 Poster

Untersuchung von angeregten Zuständen in He-artigem Uran durch Messung des $^3P_0$ Zustands — •Regina Reuschl[1,2], Heinrich Beyer[2], Dieter Liesen[2], Daniel Thorn[1,2], Danyal Winters[2] und Thomas Stöhlker[2,3] — [1]ExtreMe Matter Institute EMMI, Darmstadt — [2]GSI Helmholtzzentrum für Schwerionenforschung, Darmstadt — [3]Ruprecht-Karls-Universität, Heidelberg

Helium-artige Ionen sind einfache Systeme, die sich hervorragend zur Untersuchung von Mehrkörpereffekten der atomaren Struktur eignen. Besonders die Beiträge der Quantenelektrodynamik (QED) in starken Feldern sind hier von Interesse. Je schwerer ein Ion ist, desto stärker sind die elektrischen Felder in der Nähe des Kerns und umso größer sind die Beiträge der QED. Aus diesem Grund ist in den vergangenen Jahren sehr stark an der theoretischen Auswertung der Korrekturterme höherer Ordnung gearbeitet worden [1].

Aufgrund geringer Energieunterschiede in den angeregten Niveaus ist es nicht immer möglich, einen direkten Zugang zu den relevanten Übergängen zu finden. Daher möchten wir mit der Beam-Foil-Spektroskopie Lebensdauermessungen des $(1s2p)^3P_0 \rightarrow (1s2s)^3S_1$ Übergangs durchführen. Diese Methode hat bereits in früheren Experimenten erfolgreich Anwendung gefunden [2,3]. Durch die Verwendung neuartiger Detektoren und somit eines verbesserten Aufbaus, möchten wir die Genauigkeit der bisherigen Lebensdauermessungen des 2^3P_0 Zustands um eine Größenordnung verbessern.

[1] A. Artemyev et al., PRA **71**, 062104 (2005) [2] S. Toleikis et al., PRA **69**, 022507 (2004) [3] S. Toleikis et al., NIM B **235**, 197 (2005)

A 15.22 Di 16:30 VMP 9 Poster

Methoden zur hochgenauen Laserspektroskopie verbotener Übergänge in hoch geladenen Ionen — •Manuel Vogel[1], Wilfried Nörtershäuser[2], Wolfgang Quint[2] und Richard Thompson[1] — [1]Imperial College London, SW7 2BZ London — [2]GSI, 64291 Darmstadt

Wir präsentieren eine Reihe experimenteller Methoden zur hochgenauen spektroskopischen Bestimmung verbotener Übergänge in hoch geladenen Ionen mit relativen Unsicherheiten von etwa 10^{-7} bis unter 10^{-10}. Augenmerk liegt auf Feinstruktur- und Hyperfeinstruktur-Übergängen, die sich im zugänglichen Bereich für Laseranregung befinden. Die Methoden basieren auf der Speicherung extern erzeugter Ionen in einer Penning-Falle bei Temperaturen von 4 K und nutzen die entsprechend niedrige Teilchengeschwindigkeit sowie spezielle Manipulationen der Speicherbewegungen. Der Nachweis der Übergänge erfolgt entweder optisch oder aber rein elektronisch. Kandidaten für Messungen der Feinstruktur sind leichte bor- und kohlenstoff-artige Ionen. Für Hyperfeinstruktur-Übergänge sind schwere wasserstoff- und lithium-artigen Ionen interessant. Derartige Messungen mit den hier möglichen Präzisionen stellen hochempfindliche Tests theoretischer Vorhersagen im Rahmen der QED gebundener Zustände dar. Sie erlauben zugleich Zugriff auf das magnetische Moment des Elektrons, sowie das des Atomkerns in Abwesenheit diamagnetischer Abschirmung. Die zugehörigen Experimente befinden sich im Rahmen des HITRAP-Projekts der GSI, Darmstadt, im Rahmen der SPARC-Kollaboration und des Zukunftsprojektes FAIR im Aufbau.

A 15.23 Di 16:30 VMP 9 Poster

Mg-Candidate for an optical atomic clock — •Temmo Wübbena[1], Jan Friebe[1], Matthias Riedmann[1], Andre Pape[1], Osama Terra[2], Gesine Grosche[2], Wolfgang Lipphardt[2], Harald Schnatz[2], Ernst M. Rasel[1], and Wolfgang Ertmer[1] — [1]Institute of Quantum Optics, University of Hanover, Welfengarten 1, 30167 Hannover — [2]Physikalisch-Technische Bundesanstalt, Bundesallee 100, 38116 Braunschweig, Germany

Mg belongs to the small group of the elements suitable for a next generation optical atomic clock. We have recently measured the frequency of the clock transition $(3s^2)^1S_0 \rightarrow (3s3p)^3P_1$ on a thermal atomic beam apparatus with an accuracy on the level of 10^{-12}. From this measurement we could derive the frequency of the strongly forbidden $(3s^2)^1S_0 \rightarrow (3s3p)^3P_0$ intercombination transition which will be of interest as a clock transition for a future lattice clock. In this poster we present the current status of our work towards the realization of an optical lattice clock with Mg including an improved frequency measurement based on cold Mg atoms via telecom fiber network and a characterization of our new MOT in the triplet system. This metastable MOT serves as an efficient detector for the atoms that were excited in our Ramsey Borde atom interferometer. At the same time it will be the starting point for new cooling approaches since the cooling in the triplet system is not limited by the Doppler theory and we expect to reach temperatures which enable efficient loading an optical dipole trap.

A 15.24 Di 16:30 VMP 9 Poster

Polarisationsmessungen Radiativer Einfangstrahlung in Uran und Xenon mit neuartigen 2D Halbleiterdetektoren — Sebastian Hess[1,2], Harald Bräuning[1], Sabrina Geyer[1,2], •Ajay Kumar[1], Renate Märtin[1,2], Regina Reuschl[1,2], Uwe Spillmann[1], Martino Trassinelli[3,1], Sergej Trotsenko[1,2], Siegbert Hagmann[1,2], Günter Weber[1,4] und Thomas Stöhlker[1,4] — [1]GSI, Hemholtzzentrum für Schwerionenforschung GmbH — [2]Institut für Kernphysik, Universität Frankfurt — [3]Universite Pierre et Marie Curie-Paris 6 — [4]Physikalisches Intitut, Universität Heidelberg

Neuartige energie- zeit- und ortsauflösende 2D Halbleiterdetektoren erlauben seit jüngster Zeit die Messung der Polarisation von Röntgenstrahlung aus atomphysikalisch relevanten Prozessen. Am Experimentierspeicherring der GSI, verwendeten wir einen 2D Silizium Detektor als Compton Polarimeter, um die Polarisation der Strahlung des Radiativen Elektroneneinfangs in die K- und erstmals auch in die energetisch partiell aufgelösten L-Schalen von nacktem sowie wasserstoffähnlichem Uran experimentell zu erschließen. Außerdem nutzten wir den Radiativen Einfang in die K-Schale von nacktem Xenon, um die Vorgänge in dem Detektor mit einer aktiven Fläche von 64 x 64 mm und einer Dicke von 7mm sowie einer Aufteilung von jeweils 32 einzeln auslesbaren Streifen auf Vorder- und Rückseite im Detail zu untersuchen.

A 15.25 Di 16:30 VMP 9 Poster

Improved measurement of the 2S hyperfine splitting in atomic hydrogen and 1S-2S isotopic shift in deuterium — •Janis Alnis, Arthur Matveev, Nikolay Kolachevsky, and Theodor Hänsch — MPI of Quantum Optics, Garching near Munich

Atomic hydrogen is the simplest atom that can be calculated theoretically with great precision and better experimental data allow to make higher order Quantum Electrodynamics (QED) corrections. In 2008 we have performed a series of measurements allowing to improve the precision of a 2S hyperfine structure (HFS) interval more than two times comparing to the 2004 result [1] and the new value is 177556834.3(6.7) Hz [2]. An important improvement was to perform measurements using two independent stable laser systems simultaneously. The spectroscopy laser was scanned sequentially across the singlet and the triplet 1S-2S two-photon transitions while the reference laser [3] was all the time locked to a stable Fabry-Perot cavity. This method allowed to detect immediately any instabilities in spectroscopy laser frequency during the laser scanning and re-locking. As a next step we propose to remeasure the isotopic shift of the 1S-2S transition between atomic hydrogen and deuterium.

1. N. Kolachevsky, et al., Phys. Rev. Lett. **92**, 033003 (2004)
2. N. Kolachevsky et al., arxiv.org
3. J. Alnis et al. Phys. Rev. A. **77**, 053809 (2008)

A 15.26 Di 16:30 VMP 9 Poster

A trapped-ion phonon laser — •S Knünz[1], V Batteiger[1], M Herrmann[1], T Udem[1], T W Hänsch[1], and K Vahala[2] — [1]MPQ, Hans Kopfermann-Strasse, 85748 Garching — [2]California Institute of Technology, Pasadena, CA 91125

A single trapped Mg^+ ion is laser-cooled within a Paul trap by a red-detuned laser. Illuminated with a blue-detuned pump laser the ion exhibits oscillatory motion with a well defined threshold. We show that this is not the result of heating but of stimulated emission of center-of-mass phonons, constituting the mechanical analog of a laser.

A 15.27 Di 16:30 VMP 9 Poster

daming in 2D and 3D dilute Bose gas — •Ming-Chiang Chung — Academia Sinica Taiwan

Damping in 2D and 3D dilute gases is investigated using both the hydrodynamical approach and the Hartree-Fock-Bogoliubov (HFB) approximation . We found that the both methods are good for the Beliaev damping at zero temperature and Landau damping at very low temperature, however, at high temperature, the hydrodynamical approach overestimates the Landau damping and the HFB gives a better approximation. This result shows that the comparison of the theoretical calculation using the hydrodynamical approach and the experimental data for high temperature done by Vincent Liu (PRL **21** 4056 (1997)) is not proper. For two-dimensional systems, we show that the Beliaev damping rate is proportional to k^3 and the Landau damping rate is proportional to T^2 for low temperature and to T for high temperature. We also show that in two dimensions the hydrodynamical approach gives the same result for zero temperature and for low temperature as HFB, but overestimates the Landau damping for high temperature.

A 15.28 Di 16:30 VMP 9 Poster

Matter-wave interference on an atom chip — •Philipp Wicke, Shannon Whilock, Jan-Joris van Es, Aaldert van Amerongen, and Klaasjan van Druten — University of Amsterdam, The Netherlands

Atom chips are extremely versatile tools for trapping and manipulating quantum gases on a micrometer scale in close proximity to a surface. They can produce tightly confining magnetic potentials and provide unprecedented experimental access to novel low dimensional regimes [1]. Recently we have investigated radio frequency dressed potentials on atom chips, which provide even further control over the associated trapping potentials [2]. In general, the three-dimensional rf-dressed potential forms a connected pair of one-dimensional waveguides, used to coherently split a single Bose condensate in two parts and to observe matter wave interference upon overlap. We study the phase coherence of quasi-condensates from the resulting interference patterns, observed simultaneously in both the transverse and longitudinal directions. These experiments probe the dynamics of quantum-degenerate Bose gases in the one-dimensional regime. Possible future directions include fundamental studies of two-component quantum gases and soliton formation for two coupled condensates.

[1] van Amerongen et al., Phys. Rev. Lett. 100, 090402 (2008)
[2] van Es et al., Phys. Rev. A 77, 063623 (2008)

A 15.29 Di 16:30 VMP 9 Poster

Superconducting Microtraps for Cold Atom Experiments — •Florian Jessen, Daniel Cano, Brian Kash, Helge Hattermann, Max Kahmann, Dieter Kölle, Reinhold Kleiner, Claus Zimmermann, and József Fortágh — Center for Collective Quantum Phenomena and their Applications, Auf der Morgenstelle 14, 72076 Tübingen

We report on the realization and characterization of an experimental system to produce Bose-Einstein Condensates in a superconducting chip. Ultracold ^{87}Rb atomic clouds are produced in a magneto-optical trap and further cooled by evaporative cooling in an Ioffe trap. The atoms are transported from the Ioffe trap to the superconducting chip by means of optical tweezers. The superconducting chip is attached to the cold finger of a Helium-flow cryostat. We show recently-built superconducting chips that have been designed to minimize the impact of the Meissner effect on the magnetic potentials. In general, the Meissner effect reduces the trap depth as this is brought close to the superconducting surface [1]. These chip structures will allow experimental studies on interactions between superconductors and ultracold atom clouds. [1] D. Cano *et al.*, Phys. Rev. A **77**, 063408 (2008)

A 15.30 Di 16:30 VMP 9 Poster

Towards a Gross-Pitaevskii-Boltzmann Equation — •Luis Rico Perez and James Anglin — Technische Universität Kaiserslautern

Despite many progresses in the theoretical description of cold atoms have been achieved, the search of a general but at the same time simple formalism explaining nonequilibrium phenomena in cold bosons - as the condensation process, heating or collisions between two of them - is still an interesting problem. We develop a simple description of cold interacting bosons based on the single particle density matrix rather than the macroscopic wave function, which is therefore able to include thermodynamic properties of the gas on an equal footing with Gross-Pitaveskii mean field dynamics. Our theory includes incoherent scattering as well as Gross-Pitaevskii coherent interaction, by adapting Boltzmann's classical *Stosszahlansatz* to time-dependent s-wave scattering of wave packets.

A 15.31 Di 16:30 VMP 9 Poster

Design and setup of a trap for ultracold lithium atoms as a scattering target for cold atom-molecule collision studies — •Tim Eichhorn, Matthias Strebel, Marcel Mudrich, and Frank Stienkemeier — Physikalisches Institut, Universität Freiburg, Hermann-Herder-Str. 3, 79104 Freiburg, Germany

In order to experimentally investigate reactive and non-reactive collisions we plan to combine a magneto-optical trap and a magnetic trap with a setup for producing slow beams of cold molecules by means of supersonic expansion from a rotating nozzle. Studying scattering processes, e.g. Li + HF -> LiF + H, with collision energies down to 1 meV we expect to get insight into the quantum mechanical nature of cold reaction dynamics.

For trapping lithium atoms at very low temperatures we present calculations and design features for a compact setup consisting of a magneto-optical trap (MOT) and a magnetic trap. The MOT will be loaded from a decreasing field type Zeeman-slower and operated with a high-power diode laser system, which is based on a master-slave scheme.

A 15.32 Di 16:30 VMP 9 Poster

Local superfluidity in finite 2D helium systems — •Jens Böning, Alexei Filinov, and Michael Bonitz — Institut für Theoretische Physik und Astrophysik, Christian-Albrechts Universität, Kiel, Germany

It was shown previously[1], that the superfluid density vanishes nonhomogeneously upon density induced freezing in harmonically trapped 2D systems of charged bosons. While the total superfluid fraction declines, the radial distribution of the superfluid density becomes localized either in the core or at the boundary of the system. Our investigations revealed that the driving mechanism behind this behavoir is related to the hexagonal ordering in the system. In this work we extend our analysis to 2D systems of trapped helium atoms. We consider two kinds of trapping, firstly a harmonic trap as used in our Coulomb systems, and secondly a hard wall confinement. We employ the path-integral Monte-Carlo method with worm algorithm extension[2] for our simulations which requires no approximations on interaction potentials.

[1] A. Filinov, J. Böning, M. Bonitz, and Yu. Lozovik, *Phys. Rev. B* **77**, 214527 (2008)
[2] M. Boningsegni, N. V. Prokof'ev, and B. V. Svistunov, *Phys. Rev. E* **74**, 036701 (2006)

A 15.33 Di 16:30 VMP 9 Poster

An ultracold fermion mixture of ^{6}Li and ^{40}K — •Antje Ludewig, Tobias Tiecke, Sebastian Kraft, Steve Gensemer, and Jook Walraven — University of Amsterdam, The Netherlands

We report on the creation of an ultracold mixture of the fermionic alkali isotopes ^{6}Li and ^{40}K in an optical dipole trap. In the same trap we have realized a three-component degenerate spin mixture of ^{40}K . To create the mixtures we start by loading a two-species magneto-optical trap (MOT) from two separate 2D-MOT sources. This is the first time a 2D-MOT source is realized for lithium. The source is clean, cold (30 m/s) and yields 3D-MOT loading rates of up to 10^9 ^{6}Li atoms/s. The mixtures are then captured in an optically-plugged magnetic quadrupole trap. The plug is realized with a 10 W Verdi (532nm) focused to a 14 μm waist. After forced evaporative cooling on the F=9/2-F=7/2 hyperfine transition of ^{40}K to a temperature of 10 μK the ^{6}Li - ^{40}K mixture can be loaded in the optical dipole trap. The lithium temperature follows by sympathetic cooling. Thus so far we have realized degenerate spin mixtures of 10 ^{6} ^{40}K-atoms at T = 0.3(1)TF. For the dipole trap we use a 5 W IPG fiber laser (1070 nm) focused to a 20 μm waist. By translating the dipole trap focus we have - without significant losses - transported an ultracold sample of ^{40}K over a distance of 16 cm into a science cell. We report on our progress investigating many-body phenomena close to a Feshbach resonance using coils designed for high homogeneity.

A 15.34 Di 16:30 VMP 9 Poster

Berezinskii-Kosterlitz-Thouless transition in two-dimensional dipole systems — •Alexey Filinov[1,3], Nikolay Prokof'ev[2], Michael Bonitz[1], and Yurii Lozovik[3] — [1]Institut für Theoretische Physik und Astrophysik, Christian-Albrechts-Universität, Leibnizstr. 15, D-24098 Kiel, Germany — [2]Department of Physics, University of Massacusetts, Amherst, Massachusetts 01003, USA — [3]Institute of Spectroscopy of the Russian Academy of Sciences, Troitsk, Russia

Dilute dipole gases of polar molecules and indirect excitons in quantum wells are of increasing interest in recent experimental realizations [1,2], since they allow to realize and control correlations and quantum degeneracy effects. Using path integral Monte Carlo we investigate the normal-superfluid transition in a system of 2D bosonic dipoles which models such experiments in the full temperature-density plane. The critical temperature, superfluid fraction, thermodynamic sound speed and compressibility have been evaluated for different dipole coupling strengths/densities. For indirect excitons at high densities the dipole approximation becomes invalid. We, therefore, take into account the internal exciton structure and derive new effective interaction which crucially effects the phase diagram at high densities.

[1] J.M. Sage *at al.*, Phys. Rev. **94**, 203001 (2005); D. Wang *at al.*, Phys. Rev. **93**, 243005 (2004). [2] Timofeev V *et al* 2007 *J. Phys: Cond. Matt.* **19** 295209.

A 15.35 Di 16:30 VMP 9 Poster

Efficient guiding of cold atoms through a photonic band gap fiber — •Stefan Vorrath[1], Sönke Möller[1], Kai Bongs[2], and Klaus Sengstock[1] — [1]Institut für Laser-Physik, Universität Hamburg, Luruper Chaussee 149, 22761 Hamburg, Germany — [2]MUARC, School of Physics and Astronomy, University of Birmingham, Edgebaston, Birmingham B15 2TT, UK

We report on the first demonstration of guiding cold atoms through a photonic band gap fiber. The setup consists of a sample of cold atoms from a MOT which is transferred into a red detuned optical dipole trap laser beam which guides the atoms through a 12μm hole within the photonic fiber.

A very promising environment for further experiments seems to be the nearly perfect 1D optical potential inside the hollow core of the fiber. By measuring the number of atoms transferred through the fiber we have estimated a very high atomic density. This leads to a very high optical depth inside the fiber and can possibly be used for studying nonlinear optical effects in a regime of very low optical power but very strong atom-light interaction.

A 15.36 Di 16:30 VMP 9 Poster

Density of states for a cold Bose gas in an optical dipole trap — •Lena Simon and Walter T. Strunz — Institut für theoretische Physik, TU Dresden, 01062 Dresden

Optical dipole traps are frequently employed to provide confining potentials for neutral atoms, as practiced in the Helm group at the university of Freiburg. According to this experiment we study an ultracold Bose gas in an optical dipole trap consisting of one single focused laser beam. An analytical expression for the corresponding density of states beyond the usual harmonic approximation is obtained. We are thus able to determine the critical temperature for Bose-Einstein condensation and find that it depends on a cutoff parameter. Moreover, we study the dynamics of plain and forced evaporative cooling and observe a significant deviation from the well-established harmonic approximation.

A 15.37 Di 16:30 VMP 9 Poster

EIT and cooling by EIT in an optical dipole trap — •Andreas Ahlrichs, Carl Basler, Christoph Käfer, Maryam Roghani, and Hanspeter Helm — Physikalisches Institut, Albert-Ludwigs-Universität Freiburg

We attempt an experiment in which Rb-atoms which are pre-cooled in a UHV MOT and then transferred into a CO_2-laser trap are cooled further by electro-magnetically-induced transparency. The scheme is that predicted to work in a recent publication (MR and HH PRA 77 043418 (2008)) even under conditions far from the Lamb-Dicke limit. In this presentation we discuss the limitations which should appear in EIT-cooling of neutral atoms and the rather stringent experimental conditions required to be met for successful implementation of the scheme. The storage time of 1 minute which we achieved in our single beam CO_2-laser trap appear well sufficient to cool over the required millisecond time period. We hope to also present first experimental results on this topic.

Research supported by DFG HE2525/7-1

A 15.38 Di 16:30 VMP 9 Poster

Spin Struktur von Rb-Spinor-Kondensaten — •Hosnieh Safaei Katoli und Daniela Phannkuche — I. Institut für Theoretische Physik, Universität Hamburg, Jungiusstr. 9, 20355 Hamburg, Germany

Spinor-Kondensate sind Modellsysteme, an denen magnetische Strukturenin Reinform untersucht werden können. Ihre magnetischen Phasen resultieren aus der spinabhängigen Wechselwirkung in Bezug auf die Streulängen der Atome eines Bose-Einstein-Kondensats (BEC) und können durch äußere Magnetfelder beeinflusst werden. Wir untersuchen numerisch die Entwicklung der Spin-Strukturen von Rb-Atomen im F = 1 und F = 2-Zustand mit Hilfe der mehrkomponentigen Gross-Pitaevski-Gleichung, die die Eigenschaften von BEC erstaunlich gut beschreibt. Für ein F=1 System unter der Nebenbedingung einer verschwindenden z-Komponente des Gesamtspins führt das Wechselspiel von linearem und quadratischem Zeeman-Effekt zu drei unterschiedlichen magnetischen Phasen, die sich durch die Besetzung der einzelnen Spin-Komponenten charakterisieren lassen. In der ferromagnetischen Phase kann die Fz = 1-Domäne von der Fz = 1-Domäne durch ein Gradienfeld räumlich getrennt werden. In Abwesenheit eines magnetischen Feldes existieren für F = 2-Systeme drei verschiedene Phasen, die sich auf Grund unterschiedlicher spinabhängiger Wechselwirkungen ausbilden.In unserem Beitrag untersuchen wir den Einfluss des Zeeman-Effektes auf diese Phasen.

A 15.39 Di 16:30 VMP 9 Poster

The thermal Bose gas - a stochastic approach — •Sigmund Heller and Walter T. Strunz — Institut für Theoretische Physik, Universität Dresden

Temperature dependent quantities like spatial correlation functions [1], density fluctuations [2] and interference contrast [3] are measured in current experiments with ultracold Bose gases. In order to describe these experiments, we present a novel stochastic evolution equation, which enables us to obtain the thermal state of the canonical ensemble. The equation provides a full quantum field description and therefore does not suffer from cutoff problems, which usually occur for classical field equations. Furthermore, it is possible to solve the equation in position space with suitable effort - no knowledge of eigenfunctions or eigenenergies of the external potential is required. The equation is derived for the non interacting case, but drawing on analogies with the classical case, it is more than tempting to include the interaction in a mean field sense. We present numerical simulations for the ideal and for the interacting gas and calculate many different quantities like the ground state occupancy, variance of the ground state occupancy and spatial correlation functions.

[1] I. Bloch, T.W. Hänsch and T. Esslinger, Nature 403, 166 (2000).

[2] J. Esteve, J. B. Trebbia, T. Schumm, A. Apect, C. I. Westbrook, and I. Bouchle, Pyhs. Rev. Lett. 96, 130403 (2006).

[3] R. Gati, B. Hemmerling, J. Fölling, M. Albiez and M. K. Oberthaler, Phys. Rev. Lett. 96, 130404 (2006).

A 15.40 Di 16:30 VMP 9 Poster

Trapped interacting bosons beyond the Gross-Pitaevskii approximation — •Martin Heimsoth, Michael Bonitz, and Alexej Filinov — Institut für Theoretische Physik und Astrophysik, Christian-Albrechts-Universität Kiel, Leibnitzstraße 15

Systems consisting of cold interacting bosons show interesting collective phenomena such as Bose-Einstein condensation or superfluidity [1,3] and are currently studied in condensed matter and atomic physics. There exist several approximation methods to such systems [2]. Here we analyse the ground-state of a two-dimensional Bose system consisting, with an approximation that was first introduced by Romanovskii [2]. We extend this Method to higher particle numbers and compare the results to quantum Monte Carlo simulations.

Furthermore, an extension to the non-equilibrium regime is developed by analysing the the dynamics of the system following short-pulse laser excitations. The excitation of collective modes, such as the breathing and center-of-mass oscillation, is of particular interest.

[1] A. Filinov, J. Boning, M. Bonitz, and Yu. Lozovik. Controlling the spatial distribution of superfluidity in radially ordered coulomb clusters. Physical Review B (Condensed Matter and Materials Physics), 77(21):214527-5, June 2008.

[2] I. A. Romanovsky. Novel properties of interacting particles in small low-dimensional systems. PhD thesis, September 2006.

[3] M. Heimsoth and M. Bonitz. Physica (2009)

A 15.41 Di 16:30 VMP 9 Poster

Equilibrium properties of charge-asymmetric quantum-bilayers — •Lasse Rosenthal, Karsten Balzer, Alexej Filinov, and Michael Bonitz — Institut für Theoretische und Astrophysik, Christian-Albrechts-Uniersität, Leibnitzstraße 15, 24098 Kiel

We present a quantum-statistical treatment of the equilibrium properties of 2-dimensional quantum bilayers with spatially separated electrons and holes[1]. In the regime of intermediate coupling the system is described by solving the self-consistent Hartree-Fock equations[2].

We compute the single-particle spectrum and density profiles of up to $N = 19$ electrons and holes. The influence of different mass ratios of electrons and holes is investigated. Results of spin-polarized calculations are compared to spin unrestricted calculations.

For moderate coupling the description is extended to include correlation effects. This is done by solving Dyson's equation for the equilibrium Matsubara Greens-function.

[1]P.Ludwig, K.Balzer, A.Filinov, H.Stolz and M.Bonitz, New J.Phys.10 083031

[2]M.Bonitz, D.Semkat(Eds.), Introduction to Computational Methods in Many Body Physics, Rinton Press, Princeton (2006)

A 15.42 Di 16:30 VMP 9 Poster

Few-electron quantum dots within a nonequilibrium Green's functions study — •Karsten Balzer, David Hochstuhl, and Michael Bonitz — Institut für Theoretische Physik und Astrophysik, Christian-Albrechts-Universität Kiel, Leibnizstrasse 15, 24098 Kiel, Germany

Carrier-carrier correlations in few-electron quantum dots (QDs)—artificial atoms [1] with parabolic confinement—are studied by means of nonequilibrium Green's functions (NEGF) theory. Starting from an (un)restricted Hartree-Fock reference state, the Dyson equation is solved in the time domain [2] at zero and finite temperatures including 2nd Born and *GW* interaction kernels. We focus on strongly correlated QDs, the electron density in which is tunable by the strength of the confining potential. Considering system sizes with up to 12 electrons in one- and two-dimensional confinements, the computed ground state and equilibrium properties incorporate the self-consistent total energies, the single-carrier densities, the orbital-resolved distribution functions as well as the one-electron spectral functions [2]. The comparison of the results with Configuration Interaction [3,4] and path integral Monte Carlo [4,5] comprises the crossover from Fermi liquid to Wigner molecule or crystal behavior [5] and reveals good agreement with the NEGF approach.

[1] R.C. Ashoori, Nature 379, 413 (1996). [2] K. Balzer et al., submitted to Phys. Rev. B (2008). [3] B. Reusch et al., Phys. Rev. B 63, 113313 (2001). [4] M. Rontani et al., J. Chem. Phys. 124. 11 (2006). [5] A.V. Filinov et al., Phys. Rev. Lett. 86, 17 (2001).

A 15.43 Di 16:30 VMP 9 Poster

Quantum breathing mode of charged fermions and bosons at arbitrary coupling — •Sebastian Bauch, Karsten Balzer, Christian Henning, David Hochstuhl, and Michael Bonitz — Christian-Albrechts-Universität Kiel, Institut für Theoretische Physik und Astrophysik, Leibnizstraße 15, 24098 Kiel, Germany

We present a detailed analysis of the quantum breathing behavior of few-particle Coulomb systems in one- and two-dimensional harmonic traps. While the behavior in limiting cases, the *classical* limit and the *ideal* quantum limit, are well-known [e.g. 1, 2], we report a smooth transition behavior in between by variation of the relative interaction strength. We further show, that spin-statistic effects, i.e. the symmetry of the wave function, play an important role. We solve the many particle Schrödinger equation and compare with mean-field Hartree Fock calculations. The numerically obtained results may serve as an experimental tool to probe small interacting quantum systems.

[1] C. Henning, K. Fujioka, P. Ludwig, A. Piel, A. Melzer and M. Bonitz, Phys. Rev. Lett. **101**, 045002 (2008)

[2] M. R. Geller and G. Vignale, Phys. Rev. B **53**, 6979 (1996)

A 15.44 Di 16:30 VMP 9 Poster

Spin Struktur von Rb-Spinor-Kondensaten — •Hosnieh Safaei Katoli und Daniela Phannkuche — I. Institut für Theoretische Physik, Universität Hamburg, Jungiusstr. 9, 20355 Hamburg, Germany

Spinor-Kondensate sind Modellsysteme, an denen magnetische Strukturenin Reinform untersucht werden können. Ihre magnetischen Phasen resultieren aus der spinabhängigen Wechselwirkung in Bezug auf die Streulängen der Atome eines Bose-Einstein-Kondensats (BEC) und können durch äußere Magnetfelder beeinflusst werden. Wir untersuchen numerisch die Entwicklung der Spin-Strukturen von Rb-Atomen im F = 1 und F = 2-Zustand mit Hilfe der mehrkomponentigen Gross-Pitaevskii-Gleichung, die die Eigenschaften von BEC erstaunlich gut beschreibt. Für ein F=1 System unter der Nebenbedingung einer verschwindenden z-Komponente des Gesamtspins führt das Wechselspiel von linearem und quadratischem Zeeman-Effekt zu drei unterschiedlichen magnetischen Phasen, die sich durch die Besetzung der einzelnen Spin-Komponenten charakterisieren lassen. In der ferromagnetischen Phase kann die F_z = 1-Domäne von der F_z = -1-Domäne durch ein Gradienfeld räumlich getrennt werden. In Abwesenheit eines magnetischen Feldes existieren für F = 2-Systeme drei verschiedene Phasen, die sich auf Grund unterschiedlicher spinabhängiger Wechselwirkungen ausbilden. In unserem Beitrag untersuchen wir den Einfluss des Zeeman-Effektes auf diese Phasen.

A 15.45 Di 16:30 VMP 9 Poster

Experimental observation of oscillating and interacting matter wave dark solitons — •A Weller[1], J. P. Ronzheimer[1], C. Gross[1], J. Esteve[1], E. Nicklas[1], T. Zibold[1], M. K. Oberthaler[1], D. J. Frantzeskakis[2], G. Theocharis[3], and P. G. Kevrekidis[3] — [1]Kirchhoff Institute for Physics, University of Heidelberg, INF 227, 69120 Heidelberg, Germany — [2]Department of Physics, University of Athens, Panepistimiopolis, Zografos, Athens 157 84, Greece — [3]Department of Mathematics and Statistics, University of Massachusetts, Amherst Massachusetts 01003-4515, USA

We create pairs of stable dark solitons in a Bose-Einstein condensate by means of an interference method. In contrast to the early dark soliton experiments our setup is in the crossover regime between 1D and 3D which enables us to overcome the so called snaking instability. Therefore the created solitons are long-lived which allows the observation of their oscillations for several periods and the determination of their frequencies. During their evolution in the trap the solitons undergo multiple collisions which lead, due to their repulsive interaction, to a measureable increase in the oscillation frequency. Our results are in quantitative agreement with simulations of the Gross-Pitaevski equation and predictions on the basis of effective inter-soliton interaction.

How the interference method can be used to generate single and three solitons will also be presented.

A 15.46 Di 16:30 VMP 9 Poster

An apparatus for ultracold Fermi gases using sodium and lithium — •Jens Appmeier, Fabienne Haupert, Bernhard Huber, Raphael Scelle, Tobias Schuster, Valentin Volchkov, and Markus K. Oberthaler — Kirchhoff-Institut für Physik, Heidelberg, Germany

We report on the setup of an apparatus for cooling fermionic ^{6}Li atoms to quantum degeneracy. As a refrigerant for the fermions, ^{23}Na is used and standard cooling schemes are applied. By tuning the interactions between ^{23}Na and ^{6}Li via Feshbach resonances it is possible to study different regimes of a mixed system containing both species. The current progress of the experimental setup will be reported.

A 15.47 Di 16:30 VMP 9 Poster

Interaction of Ultracold Atoms with Carbon Nanotubes — •Philipp Schneeweiss[1], Michael Gierling[1], Gabriela Visanescu[1], Michael Häffner[2], Dieter Kern[2], Andreas Günther[1], and József Fortágh[1] — [1]Physikalisches Institut, Universität Tübingen, Auf der Morgenstelle 14, D-72076 Tübingen — [2]Institut für Angewandte Physik, Universität Tübingen, Auf der Morgenstelle 10, D-72076 Tübingen

We developed an ultracold atom experiment for studying interactions between 87Rb atoms and carbon nanotubes (CNTs). Atomic clouds are loaded in a MOT and transported magnetically to the nanotubes that are placed on the surface of an atom chip. An integrated magnetic conveyor belt facilitates precise 3D positioning of the atoms near the CNTs. We will report on the experimental progress.

A 15.48 Di 16:30 VMP 9 Poster

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

Over the past few years quantum degenerate mixtures particularly including bosonic and fermionic atoms have enabled a new range of experiments. Especially the use of Feshbach-resonances to tune the interaction between the atoms in these samples has contributed to the success of these experiments. We present an experimental apparatus under construction, which will allow us to investigate mixtures of one isotope of rubidium with all isotopes of potassium and also enable the use of Feshbach-resonances.

In the experimental setup the desired fermionic or bosonic isotopes are collected in a magneto-optical trap from the background vapor. 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. This process can be repeated to increase the number of atoms or to collect multiple isotopes. Subsequently sympathetic cooling is 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 investigate and manipulate the interaction strength or to form molecules.

Particular attention will be given to the design of the laser system and the field coils, which enable the flexibility of the experiment.

A 15.49 Di 16:30 VMP 9 Poster

Squeezing and entanglement in a Bose-Einstein condensate — •Christian Gross, Jerome Esteve, Andreas Weller, Stefano Giovanazzi, Eike Nicklas, Tilman Zibold, Jens Philipp Ronzheimer, and Markus Oberthaler — Universität Heidelberg, Heidelberg, Deutschland

We report on the observation of spin squeezing and entanglement in a Bose-Einstein condensate trapped in double well and periodic potential. The measurement of two conjugate variables - atom number difference and relative phase between adjacent sites - allows a direct connection to the presence of entanglement. The observations indeed confirm that entanglement is present even at finite temperature. The observed coherent spin squeezing of 3.8 dB implies that a usable quantum resource has been generated which is directly applicable to overcome the standard quantum limit of atom interferometry. The limitations due to experimental imperfections and finite temperature will be discussed in detail. Latest results on spin squeezing using hamiltonian dynamics of internal states are presented.

A 15.50 Di 16:30 VMP 9 Poster

Bose Einstein Condensates on the surface of a glass prism — •Helmar Bender, Phillipe Courteille, Claus Zimmermann, and Sebastian Slama — Physikalisches Institut, Eberhard-Karls-Universität Tübingen, Auf der Morgenstelle 14, D-72070 Tübingen

The main focus of our experiments ist the interaction of ultra cold atoms with a dielectric surface. In our case the surface is the facet of a glass prism. An evanescent wave created by total reflection of a laser beam at this facet allows us to generate a dipole potential acting on atoms close to the surface. This potential makes it possible to compensate for the attractive Casimir-Polder (CP) force which is playing a dominant role at very small distances from the surface. The sum of the two potentials is able to form a controllable barrier at a distance of only a few hundred nanometers from the surface. By using a magnetic trap we are able to shift a Bose Einstein Condensate (BEC) in a controlled way to this barrier. The atoms overlapping with the evanescent wave of a far detuned laser beam shift the phase of the totally reflected light proportionally to the number of atoms. Monitoring this phase shift as a function of time provides information on number fluctuations in a BEC. Another interesting perspective of our setup is the reflection of matterwaves from the barrier for the measurement of CP-forces. In the long term we plan to deposit nano structured metal layers on the surface. Excitation of surface plasmon polaritons in these layers enhances the evanescent wave intensity and thus the dipole potential locally. We will investigate such systems for tailoring of nanometric surface traps with the perspective of a photonic atom chip.

A 15.51 Di 16:30 VMP 9 Poster

Observation of ultra long-range Rydberg molecules — Vera Bendkowsky[1], Björn Butscher[1], •Johannes Nipper[1], Jonathan Balewski[1], James P. Shaffer[1,2], Robert Löw[1], and Tilman Pfau[1] — [1]Universität Stuttgart, Germany — [2]University of Oklahoma, USA

We report on the observation of ultra long-range molecules, first proposed by Greene et. al. [1], bound by low energy scattering of Rydberg electrons from polarisable ground state atoms. The novel binding mechanism leads to well defined internuclear separations of some thousand Bohr radii.

Rydberg states between 34S and 40S are excited in a dense cloud of magnetically trapped Rubidium. The excitation spectra show clear evidence for dimer as well as trimer molecules in the vibrational ground states and excited states. The measured binding energies coincide with theoretical calculations taking into account s- and p-wave scattering. The low energy s-wave electron scattering length could be determined. Lifetime measurements for the pure Rydberg state and the molecular dimer state show a decreased lifetime of the molecular state. The coherent excitation dynamics of the dimer and the Rydberg state are studied in rotary echo experiments.

[1] C.H. Greene et al, Phys. Rev. Lett **85**, 2458 (2000)

A 15.52 Di 16:30 VMP 9 Poster

Universal scaling in a strongly interacting Rydberg gas — •Robert Löw[1], Vera Bendkowsky[1], Björn Butscher[1], Johannes Nipper[1], Hendrik Weimer[1], Jonathan Balewski[1], James P. Shaffer[1,2], Hans Peter Büchler[1], and Tilman Pfau[1] — [1]Universität Stuttgart, Germany — [2]University of Oklahoma, USA

Universal scaling near a quantum critical point is theoretically analyzed and experimentally demonstrated in a strongly interacting Rydberg gas.

The experiments are performed in a dense cloud of magnetically trapped Rubidium atoms resonantly driven into a Rydberg state. Due to the strong van-der-Waals interaction of the Rydberg atoms blockade effects occure. The coherent collective excitation dynamics were recently studied [1]. We show that the experimental data show a collapse to a universal scaling function in one single dimensionless parameter.

The system can theoretically be described by a mean field model [2] that show a universal scaling near an experimentally accessable critical point. Numerical simulations as well as the mean field model are in good agreement with the experimentally observed critical exponents.

[1] Heidemann et al, PRL 100, 013002 (2007)
[2] Weimer et al, PRL in press

A 15.53 Di 16:30 VMP 9 Poster

Signature of long-range-molecules in a dipole blocked degenerate atom gas — •Weibin Li and Thomas Pohl — Max-Planck-Institut für Physik komplexer Systeme, Dresden, Germany

The low energy scattering from the Rydberg-electron and a surrounding ground-state atom in ultracold gases yields an attractive potential, giving rise to exotic, ultralong range molecules [1], for which experimental evidence has been reported recently [2]. Here, we study the coherent excitation dynamics in dipole blocked mesoscopic ensembles, in which all but a single excitation is inhibited by the strong Rydberg-Rydberg interaction. We develop a large scale Monte-Carlo approach to describe the fully correlated excitation dynamics. In particular we study the effect of the interactions on the coherence properties of collective, many-body Rabi oscillations, which are important for proposed applications in quantum information. Finally, we examine possible approaches to experimentally probe the highly structured molecular potential curves.

[1] C. H. Greene, A. S. Dickinson and H. R. Sadeghpour, Phys. Rev. Lett. 85, 2458 (2000).
[2] V. Bendkowsky, et.al., arxiv:0809.2961 (2008).

A 15.54 Di 16:30 VMP 9 Poster

Excitation of Rydberg atoms in an ultracold gas by a rotary echo sequence — •Sebastian Wüster[1], Cenap Ates[1], Thomas Pohl[1], Piotr Deuar[2], Joel Corney[3], and Jan-Michael Rost[1] — [1]Max Planck Institute for the Physics of Complex Systems, Dresden, Germany — [2]Université Paris-Sud, CNRS, Orsay cedex, France — [3]ARC Centre of Excellence for Quantum-Atom Optics, School of Physical Sciences, University of Queensland, Brisbane, Australia

We model the excitation and subsequent de-excitation of Rydberg states in a Bose-Einstein condensate. Our method, stochastic Gauge-P quantum many-body theory, can in principle provide the complete quantum field dynamics of a many-mode, many-particle problem for a softened long-range interaction potential. Typically intractably large Hilbert-space sizes are tackled by representing quantum correlations numerically through noise correlations. As a trade-off, the amplification of this noise intrinsically limits the possible simulation times.

The aim is to study spatial correlations among the remnant fraction of Rydberg atoms, following an echo sequence. This sequence consists of an excitation pulse, followed by a de-excitation pulse of equal duration that would return all atoms to the ground state if there were no interactions. The long-range dipolar interactions between Rydberg states cause dephasing, resulting in a remnant Rydberg population after the sequence.

A 15.55 Di 16:30 VMP 9 Poster

Rydberg atom formation in strongly correlated ultracold neutral plasmas — •Georg Bannasch and Thomas Pohl — Max-Planck-Institut für Physik komplexer Systeme, Nöthnitzer Str. 38, 01187 Dresden

In plasmas at very low temperatures the recombination into neutral atoms is known to be dominated by three-body recombination, owing to the strong $\sim T^{-9/2}$ scaling with the electron temperature. While this law is well proven at high temperatures, the unphysical divergence as $T \rightarrow 0$ clearly suggest a breakdown in the low-temperature regime. Despite ongoing debates about its extension into the low-temperature, and consequently strong coupling regime, a conclusive answer is still missing.

The advent of ultracold neutral plasmas has refocussed interest in recombination under such exotic conditions, and experimental studies of the involved questions may be anticipated.

Here we present a combined molecular dynamics - Monte Carlo study of electron-ion recombination over a wide range of temperatures and densities. Our calculations reach far into the strongly coupled regime, in which the charges may be nearly crystallized. Such unusual neutral plasma states clearly defy common few-particle collision models, and their lifetime and stability is yet to be determined.

A 15.56 Di 16:30 VMP 9 Poster

Towards single lattice site addressability using ultracold Rydberg atoms — •Ulrich Raitzsch[1], Richard Abel[1], Ashok Mohapatra[1,2], Mark Bason[1], Jonathan Pritchard[1], Kevin Weatherill[1], and Charles Adams[1] — [1]Atomic & Molecular Physics, Durham, U.K. — [2]5. Physikalisches Institut, Universität Stuttgart, Germany

We present our recent progress towards single lattice site addressability using Rydberg atoms. The large polarisability α of Rydberg states makes it possible to selectively excite atoms at a single lattice site into a Rydberg state using electric field gradients. In our experimental scheme the atoms are loaded from a magneto-optical trap into a one-dimensional lattice with $\sim$ 600 nm lattice constant. A Rydberg state with a principal quantum number $n = 70$ can be addressed by a moderate electric field gradient. Using a novel scheme for laser locking to any excited state transition, we demonstrate a combined two-photon excitation linewidth to the Rydberg state of $\leq$ 200 kHz [1], which is sufficiently small to exclusively address a single lattice site.

[1] R. Abel et al., arXiv:0811.2183v1 (2008)

A 15.57 Di 16:30 VMP 9 Poster

Adiabatic energy transfer in Rydberg chains — •Cenap Ates, Alexander Eisfeld, and Jan-Michael Rost — Max Planck Institute for the Physics of Complex Systems, Nöthnitzer Str. 38, 01187 Dresden, Germany

Ultracold Rydberg systems are ideally suited to study excitonic transport through ordered structures. The energy transfer is mediated by the strong transition dipole-dipole interactions between Rydberg atoms. As has been shown recently, the excitonic dynamics is also correlated with the motion of the atoms. The structure of the excitonic eigenfunctions determines how the particles move. We analyze the motion of Rydberg atoms prepared on an equidistant chain, where the regularity of the spacings is broken at one end. It is shown that the irregularity can move adiabatically through the chain. Coupled to this motion is a transfer of electronic excitation localized on the irregularly spaced particles. The energy transfer takes place on a single adiabatic potential surface. It should be stable against effects of dephasing.

A 15.58 Di 16:30 VMP 9 Poster

Collective modes in ultracold plasma — •Andrii Liubonko, Thomas Pohl, and Jan-Michael Rost — Max Planck Institute for the Physics of Complex Systems, Nöthnitzer Straße 38, 01187 Dresden, Germany

Ultracold neutral plasmas (UCP) are formed by photoionizing laser cooled atoms near the ionization threshold [1,2]. The electron temperature is from 1-1000K and the ion temperature is around 1K. The fundamental interest in these systems originates in the possibility of creating strongly coupled plasma. Recently, a series of collective modes of an UCP were observed in the experiment [3]. Numerical simulations of this effect within molecular dynamics will be presented. The results show that collective modes in an UCP, previously identified with Tonks-Dattner resonances, have a different nature, which stems from the fact, that UCP is not confined. Existing theory based on cold plasma theory does not provide an explanation of these resonances. We extend the theory to the finite temperature. Possible approaches to cope with this problem will be discussed.

1.T. C. Killian, Science 316, 705 (2007). 2.T.C. Killian, T. Pattard, T. Pohl, J.M. Rost, Phys.Rep. 449 (2007). 3.R. S. Fletcher, X. L. Zhang, and S. L. Rolston, Phys. Rev. Lett., 96:105003 (2006).